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A POWERFUL RISE IN FERROUS METALLURGY

S. M. Filippov

Chief Specialist of the USSR State Plan
Translated from Metallurg, No. 1,
pp. 1-3, January, 1961

Soviet metallurgists have achieved remarkable successes in 1960. The entire country praises their labor. The increased tasks of the second year of the Seven-Year Plan have been overfulfilled in the production of ferrous metals in the Soviet Union as a whole and in the majority of Union Republics.

The volume of the production of pig iron, steel, and rolled products considerably increased in 1960, the extraction of iron ore increased, new industrial facilities were put into operation. Thanks to the further increase in the leadership of the economic construction on the part of the council, party, and trade union organizations, thanks to the widely developed socialist competition and the movement of brigades and shock-workers of communist labor, the metallurgical enterprises considerably overfulfilled the tasks of the economic plan and control figures of the Seven-Year Plan.

The 1960 plan was overfulfilled: our country received additionally about 200,000 t of pig iron, more than 300,000 t of steel, about 500,000 t of rolled products, about 1.5 million tons of iron ore.

During the two years of the Seven-Year Plan, about 1 million tons of pig iron, about 5 million tons of steel, about 4 million tons of rolled products have been produced above the assignments of the Seven-Year Plan and more than 6 million tons of iron ore extracted.

The plan was not fulfilled with respect to the production of steel tubes due to the delay in putting into operation and the slow mastering of the new shop for the continuous furnace welding of tubes at the Chelyabinsk Tube-Rolling Plant and of the new electric-welding tube shop at the Novosibirsk Metallurgical Plant.

The volume of capital construction in ferrous metallurgy in 1960 exceeded the volume of investment for the previous year by 17%. In the past year many industrial facilities were put into operation, including four powerful blast furnaces, 15 large-load steelmaking furnaces, 6 rolling and 2 tube mills, as well as enterprises of the iron-ore industry with a total capacity of about 30 million tons of raw iron ore.

The Karaganda Metallurgical Plant began operation in 1960. The Orsk-Khalilovo Metallurgical Combine with the operation of the new powerful 2800-sheet mill has become an enterprise with a complete metallurgical cycle.

The world's largest blast furnace, completely automated and mechanized, began operation at the Lenin Krivoi Rog Metallurgical Plant. The furnace will operate according to the most perfected technology. In order to increase the smelting of pig iron, the use of natural gas, enriched with oxygen of the blast at a constant moisture content, heated to 1200° is planned; the gas pressure under the top is up to 2.5 atm. The capital expenditures per ton of pig iron were reduced by 12% and the productivity of labor increased by 18%.

It is necessary to note in particular that at the giant furnaces the labor of the furnace attendants has been considerably facilitated. The casting yard has been equipped with two cranes; a powerful electrical machine was installed for opening and closing the tap hole. The pig iron and slag are poured by means of stationary and mechanized swivel troughs with push rods. The control point of the furnace and the blast stoves was taken out of the working area to a separate room. An automatic conveyer line for the delivery of the charge was developed

at the Krivoi Rog furnace on the basis of the experience of the Magnitogorsk metallurgists. Here the maximum attention to the needs of the workers is manifested. A special system of ventilation and humidification creates normal sanitary and hygienic working conditions in the rooms of the blast-furnace shop.

The progressive industrial methods for rapid construction which were used by the Ukrainian blast-furnace builders made it possible to accomplish the construction of a gigantic furnace in a very short time—less than 11 months.

Large-scale technically perfected blast furnaces were built and put into operation in 1960 at the Kuznetsk Metallurgical Combine and at the Karaganda, Alchevskii, and Enakievo Metallurgical Plants.

New open-hearth furnaces began operation at the Magnitogorsk, Nizhne Tagil, and Orsk-Khalilovo Metallurgical Combines, at the Krivoi Rog, Cherepovets, and Azerbaidzhan Metallurgical Plants, and new electric steel-making furnaces at the "Dneprospetsstal'" and Chelyabinsk Metallurgical Plants.

The furnaces of the Krivoi Rog Metallurgical Plant, the largest furnaces in Europe, were constructed with the latest achievements of Soviet steelmaking technology taken into account. They are equipped to operate on natural gas and oxygen. The delivery of the pig iron to the furnaces from the mixing department is accomplished by ladles having an increased capacity; 15-ton charging machines were installed. The heat conditions are controlled by computers.

At the "Dneprospetsstal'" Plant the electric steelmaking furnaces are equipped with devices for electromagnetic mixing of the molten metal, which greatly facilitates the work of the steelworkers, accelerates the melting process, and increases the quality of the metal.

Television has started to be used in open-hearth production, which makes it possible to facilitate considerably the work of the steelworkers and to prolong the run of the furnace.

One of the most important progressive achievements of contemporary ferrous metallurgy is the continuous pouring of steel. The world's largest installation for the continuous pouring of steel was put into operation in 1960 at the Stalinsk Metallurgical Plant. It is calculated for pouring a melt weighing 130-140 t simultaneously into four channels for slabs 120-520 mm thick and 650-1000 mm wide.

The experience of operating installations for the continuous pouring of steel in the Soviet Union convincingly testifies to the need for their extensive, ubiquitous introduction into production. It is important to note that these installations can be constructed at presently-operating steelmaking shops. The use of continuous pouring has great promise for the mechanization and automation of one of the most labor-consuming and heavy metallurgical processes.

Powerful rolling mills were put into operation in 1960 at the Magnitogorsk and Orsk-Khalilovo Metallurgical Combines, and at the Krivoi Rog, Cherepovets Zhdanov, and other metallurgical plants.

At the Magnitogorsk Metallurgical Combine a continuous 2500-rolling mill for hot-rolling wide band sheets, the largest such mill in Europe, was put into operation, and this made the Magnitogorsk Combine one of the leading enterprises in the country in the production of rolled sheet products. It will deliver for machinery construction and building construction a steel band to 2350 mm wide. Similar mills in the USA have a rolling rate of 7-9 m/sec; the Magnitogorsk mill operates with a rate of 12 m/sec.

A new continuous 1700-sheet mill was introduced at the Il'ich Metallurgical Plant for rolling steel sheet up to 1.5 m wide and 1.2-10 mm thick. The new unit is distinguished by a high productivity, is completely without manual labor, and the use of computers is provided for in individual sections. The metal will be rolled at a rate of 12.5 m/sec. Due to the complete mechanization and automation of the productive processes, here the staff of workers will be halved as compared with those now occupied on mills of considerably less capacity at other plants.

A new, highly-productive 1700-sheet mill, being a continuation of the presently operating 2800-mill and designed for hot rolling of steel sheets 1.8-8 mm thick and up to 1.5 m wide, has been put into operation at the Cherepovets Metallurgical Plant. The productive processes are mechanized and automated.

Industrial television, designed to facilitate labor and to increase the economy and technology of production, was widely used in 1960 in the production of rolled products at a number of metallurgical enterprises.

1960 saw the introduction of the first electric-welding tube shop in Siberia at the A. N. Kuz'min Novosibirsk Metallurgical Plant and the start of the construction of a considerably more powerful tube shop.

A shop for the continuous furnace welding of tubes, which will more than triple production, began operation at the Chelyabinsk Tube-Rolling Plant. A powerful continuous mill for the furnace welding of tubes,which will turn out water- and gas-line pipes for homes and communal structures,was put into service at this plant. All the units and aggregates are completely mechanized and automated in the shop; a continuous line connecting the rolled product, machining, and finishing of the tubes is used for the first time in the world. All this increases the productivity of the equipment installed. The rolling rate on the new mill reaches to 420 m/min, whereas in England such mills roll tubes at a rate of 220 m/min, in the German Federal Republic at 300 and in the USA 383 m/min.

Many large metallurgical shops and aggregates were put into operation in 1960.

However, the plan for the capital construction in ferrous metallurgy as a whole in the past year was not fulfilled. The Councils of National Economy, the planning and construction organizations must devote greater attention to the construction of enterprises, shops, and aggregates of ferrous metallurgy.

In conformity with the resolutions of the Twenty-First Congress of the Communist Party of the Soviet Union and the subsequent plenums of the Central Committee of our Party, high rates of growth were provided for in the 1961 plan for the production of ferrous metals,with an advancing development in the production of hard-to-get types of rolled products, metalware, a further extensive introduction into production of the latest achievements of science and technology, the realization of accelerated technological progress, an increase in the quality indices of the work of metallurgical plants, and a subsequent growth in the productivity of labor, and savings in money and material resources.

In order to fulfill this expanded program for the development of ferrous metallurgy, the workers of this branch of industry must search still deeper and use more fully the resources of our enterprises, must put into effect the new, enormous potentials developed in our country for a further acceleration of the development of this key branch of heavy industry.

The 1961 plan for the output of ferrous metals is as follows, in millions of tons: Pig iron 51.2; steel 71.34; rolled products 55.27.

The increase in the output of ferrous metals as compared with the previous year is 9%, as compared with 1958, 29%. The output of steel tubes is increased by 11% as against the 1960 level. As a result of this, during the three years of the Seven-Year Plan there will be produced in addition to assigned control figures: 9.7 million tons of steel, 7.7 million tons of rolled products, and 718,000 tons of steel tubes.

The plan provides for forced development in the production of the most needed types of steel, rolled products, and tubes. In particular, it is planned to increase, in comparison with 1958, the production of electric steel by more than 30%, cold-rolled sheet steel by 42%, rolled products from low-alloy steel by a factor of more than 1.8, seamless tubes by 31%, and thin-walled electric-welded pipes by 68%.

In 1961 the volume of capital investments in ferrous metallurgy is increased by 31% as compared with 1960. It is planned to put into operation new facilities for the smelting of pig iron by 4.4 million tons and steel by 7.2 million tons, and for the output of rolled products by 4.4 million tons and steel tubes by 1 million tons. For this purpose it is planned to realize the increase in the new outputs by the construction of powerful mechanized and automated aggregates.

In order to develop the necessary raw-material base for ferrous metallurgy it is planned to put into operation in 1961 new facilities for 40 million tons of raw iron ore, which corresponds to the entire extraction of iron ore in our country in 1950.

The construction of three powerful mining-concentration combines will begin in 1961: Ingulets and Dneprovskii in Ukraine SSR and Lisakovskii in Kazakh SSR. New iron-ore deposits are being exploited in the Murmansk and Sverdlovsk regions where the Kovdorskii mine and the first line of the Kachkanarsk Mining-Concentrating Combine have been put into operation. Nineteen sintering machines with a total capacity of more than 15 million tons of sinter are being put into operation.

The capacity of the presently-active enterprises will be increased by mechanization, intensification of production, by improving the technological processes, and by taking other organizational and technological measures.

The productivity of labor at the enterprises of ferrous metallurgy in 1960 was increased by 6% as compared with the level reached in 1959. The assignment to reduce the expenditures per one ruble of commodity production was fulfilled with a certain excess. A further increase in the productivity of labor as a whole in ferrous metallurgy by 4.5% as against the 1960 level is projected for 1961, and the expenditure per one ruble of commodity production is to be reduced by 1.7% throughout the entire ferrous metallurgical industry.

The plan calls for a considerable improvement in the use of metallurgical units. The volume utilization factor for the blast furnaces for 1961 is set at 0.737 instead of 0.750 according to the 1960 preliminary report. The removal of steel from 1 m^2 of hearth area for open-hearth furnaces in 1961 is planned at 7.82 t as opposed to 7.69 t for 1960. The increase in the output of rolled products in 1961 as compared with 1960 is 4 million tons.

The production of steel tubes according to the 1961 plan is increased by 9.5%. This will be assured by a well-timed introduction into operation of starter devices. Special attention in this case should be devoted to the construction and introduction into operation within the planned period of a shop for the continuous rolling of seamless tubes at the Pervoural New-Tube Plant.

It is necessary to utilize more quickly the planned capacity of the shop started in 1960 for the continuous furnace welding of tubes at the Chelyabinsk Tube-Rolling Plant. A most rapid increment in the facilities for the production of tubes is the most important task of the workers of ferrous metallurgy in 1961.

The assignments for the development and introduction of new techniques in ferrous metallurgy were worked out ahead of time for 1961 and are now an integral part of the 1961 plan. These assignments foresee the accomplishment of extensive measures for carrying out mechanization and automation of industrial processes, the introduction of advanced technology, the mastering of the output of new and economical types of production.

In the field of scientific research in ferrous metallurgy in 1961 it is necessary to concentrate attention on carrying out studies toward:

a still broader and more efficient use of oxygen and natural gas in blast-furnace and steelmaking production;

an improvement in the technology of smelting converter steel with the use of oxygen, including the improvement in the quality of the metal and an increase in the useful output, and an increase in the service life of the brick lining;

a mastering and further increase in the efficiency of operating installations for the continuous pouring of steel;

an industrial mastering and introduction of methods of producing steel and alloys with increased properties by using a vacuum during smelting and pouring of the steel, and also by molten-slag electric remelting and by other methods;

a development and introduction of highly-productive methods of thorough beneficiation of iron and manganese ores of various deposits and varieties, and of sintering finely-pulverized concentrates for obtaining lumped materials of high basicity;

a mastering and perfecting of new technological processes of producing tubes, and also the production of new types of tubes;

automation of the industrial processes as well as an increase in the economic level of operation at enterprises of ferrous metallurgy.

The rates of development planned for ferrous metallurgy give us reason to consider that already in 1961-1962 the problem of developing a reliable base to provide fully for the increasing demands of the economy of the Soviet Union for ferrous metals will be solved in our country.

The great successes attained in the development of metallurgy and the entire economy of the USSR mean that we have already developed a strong base for realizing the fulfillment of the Seven-Year Plan, for realizing

still higher rates of growth in production and the assurance in the very shortest historical period of victory in the peaceful economic competition with capitalism.

Fulfillment of the Production Plan for Products of Ferrous Metallurgy by Union Republics for 1960, % (according to preliminary data)

Product	Total for USSR	RSFSR	Ukraine SSR	Kazakh SSR	Georgia SSR	Azerbaidzhan SSR	Uzbek SSR	Other Union Republics and Ministries
Pig-Iron	100.4	100.0	101.0	104.2	103.6	—	—	—
Steel	100.5	100.3	100.5	100.0	100.9	103.9	103.3	102.1
Rolled products	101.0	101.2	101.0	102.4	101.2	103.8	103.8	104.0
Steel tubes	99.1	97.7	100.5	—	102.5	102.0	—	100.0
Iron ore (commodity)	101.3	101.4	102.0	102.1	—	104.0	—	102.5
Manganese ore	102.9	100.0	103.8	108.3	102.9	—	—	—

FLUXED SINTER WITH INCREASED MAGNESIA CONTENT

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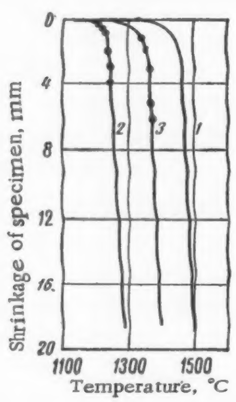
Translated from Metallurg, No. 1, pp. 4-5, January, 1961

In the process for the production of fluxed sinter with addition of limestone to the sinter charge, there is intense development of liquid phases, resulting in strongly fused brittle sinter, which breaks up during transport with the formation of a considerable quantity of fines (10-0 mm). This considerably impairs the permeability of the blast-furnace burden to gas during melting, and consequently also the technical and economical efficiency of the furnaces. This drawback can be removed to a considerable extent by replacing part of the limestone in the sinter charge by dolomite or other magnesia-containing materials (for example, Bakal siderite ore).

Magnesia, by reacting with the oxides of iron, in contrast to lime, increases their softening temperature to some extent. An addition of dolomite to the sinter charge, therefore, helps to widen and raise the temperature region of transition from the softened to the hard condition, and also to form a smaller quantity of melt, i.e.,to produce less fused and brittle sinter (see figure). An increase in the magnesia content of the sinter to 2.5-4.0% (from a calculation of the MgO content of the blast-furnace slag of up to 9%) improves the physicochemical properties of the slag, without impairing its desulfurizing capacity.



Softening of specimens of magnetite concentrates of the Serov sinter plant. 1) Pure concentrate; 2) concentrate with addition of 20% of limestone; 3) concentrate with addition of 20% of dolomite.

The following gives the results of trials* carried out on the sinter plant and in the blast furnaces of the Serov Metallurgical Combine, with partial replacement of limestone by dolomite in the sinter charge.

In the production of a fluxed sinter with increased magnesia content, basicity $[(CaO + MgO)/SiO_2]$ of the sinter remained the same as when the usual charge was used, i.e.,1.42.

Table 1 gives the results of the production of fluxed sinter with different magnesia contents. An increase in magnesia in the fluxed sinter improves its strength and reducibility. At the same time, assimilation of lime and combustion of sulfur are improved. The specific output of the sintering machine is not reduced when such a sinter is produced.

The sinter produced was smelted in two blast furnaces from October 2 to 9, 1959. Table 2 gives the working data of one of the blast furnaces showing that when smelting fluxed sinter with increased content of magnesia while preserving the basicity of the slag according to the ratio $(CaO + MgO)/SiO_2$, the sulfur content of the iron did not rise, while the furnace's technical and economical efficiency increased notably. Thus, the ore load was increased by 8.9%, and the furnace output by 5.4%, while the coke consumption decreased by 4.0%. Similar results were obtained on the second furnace.

* Besides the author, the following took part in the work: Yu. A. Gyrdymov, L. M. Shabalin, V. M. Morozov, M. V. Smetanin, and V. Kh. Vakulenko.

TABLE 1. Results of Fluxed Sinter Production with Increased Magnesia Content

Index	Fluxed sinter with magnesia content, %	
	1.0	3.4
Basicity of sinter:		
$CaO : SiO_2$	1.36	1.13
$\frac{CaO + MgO}{SiO_2}$	1.44	1.42
Composition of charge (without fuel), %:		
Ore mixture	79.6	79.4
Mill scale	1.4	1.6
Blast-furnace dust	1.2	2.2
Limestone	16.8	4.6
Dolomite	0.0	12.2
Added flux:	Limestone	Dolomite
Chemical composition, %:		
CaO	49.5	31.1
MgO	1.5	18.4
SiO_2	2.8	2.2
Content of particle size fractions, %:		
>5 mm	14.4	10.5
3-5 mm	15.8	16.6
0-3 mm	69.8	72.9
Chemical composition of sinter, %:		
Fe	48.3	48.5
FeO	19.5	18.9
CaO	16.5	13.1
MgO	1.0	3.4
SiO_2	12.1	11.8
S	0.097	0.087
Free lime content, %	1.50	0.86
Yield of 5-0 mm fraction after drum test, %	34.5*	31.9*
Reducibility, %	43.3	45.5
0-5 mm fraction content of sinter on blast-furnace gantry, %	12.0	10.6
Specific output of sintering machine, $t/m^2 \cdot hr$	1.50	1.53
Vacuum in main, mm water gauge	640	645
Waste-gas temperature, °C	110	115
Fuel consumption, kg/t of sinter	64.0	65.0
Electric power consumption, kw-hr/t of sinter	15.4	15.3

* The low strength of Serov sinter is due to the high coarseness of the charge (especially limestone and coke breeze). Work is currently in progress at the plant for the elimination of these drawbacks.

TABLE 2. Results of Smelting Fluxed Sinter with Different MgO Contents

Index	Fluxed sinter with MgO content, %	
	1.0	3.4
Raw material consumption, t/t of pig:		
Iron ore	0.177	0.121
Manganese ore	0.090	0.082
Sinter	1.785	1.887
Metal addition	0.077	0.042
Limestone	0.012	0.016
Coke (dry)	0.723	0.694
Output, %*	100.0	105.4
Blast temperature, °C	890	890
Composition of pig, %:		
Si	0.82	0.89
S	0.046	0.040
Slag yield, t/t of pig	0.731	0.718
Composition of slag, %:		
SiO_2	37.70	37.38
Al_2O_3	13.6	13.42
CaO	42.6	38.35
FeO	0.62	0.58
MnO	1.66	1.36
MgO	2.10	7.12

* The production of the furnace on fluxed sinter with 1% content of MgO is assumed to be 100%.

Thus, the trials on the partial replacement of limestone in the sinter charge by dolomite from the calculation of the production of blast-furnace slags with a MgO content of up to 9% enable the metallurgical properties of the fluxed sinter to be increased and the technical and economical efficiency of the blast-furnace process to be improved.

REDUCING THE SULFUR CONTENT OF IRON IN THE BLAST-FURNACE SMELTING PROCESS

Translated from Metallurg, No. 1,
pp. 6-7, January, 1961

The following has been received from Professor Kanamori Kuro of the Institute of Industrial Technology at Tokyo University in reply to the article by M. A. Shapovalov, published in No. 12 of the journal "Metallurg" for 1959.

For many years, I have been making investigations on the blowing of iron in the blast-furnace hearth with oxygen for the purpose of transforming the blast-furnace hearth from an inactive part to an active part. I have called this process "Bessemerizing in the blast furnace." The preliminary experiments were commenced in 1949, and in 1951-1952, we made experiments in a 3-ton blast furnace at Yawata Metallurgical Plant. After a 1-ton experimental blast furnace had been erected in our Institute in 1955, the experiments were continued in this furnace.

The results of the experiments have already been published in Japanese journals and elsewhere.

In the meantime, the Soviet journal "Stal'" (1956, No. 2, pp. 115-124) published an article about a 2000 m^3 blast furnace, in which it was stated that the supply of oxygen to the blast-furnace hearth was giving good results in Japan. The author of the article recommended that this question be studied in connection with the design of the large blast furnace.

Having read a Japanese translation of this article, I appreciated that Soviet metallurgists were interested in this question.

I recently read an article by the great metallurgist of your country, the late Ivan Pavlovich Bardin, "On new methods for the intensification of metallurgical processes," published in the journal "Metallurg", No. 1, 1960, which produced on me a profound impression. In this article, I. P. Bardin gave a positive assessment of the process of iron smelting with supply of oxygen to the blast-furnace hearth. He wrote: "It may be assumed that with such an oxygen supply, the blast-furnace hearth will cease to be a metal receiver but become an active part of the furnace with an oxidizing atmosphere, ensuring the combustion of silicon, sulfur, and in part (up to 2%) carbon."

I have also read an article by M. A. Shapovalov, "On reduction of the sulfur content of pig iron", published in the journal "Metallurg" (1959, No. 12). I also learned that there had been a discussion in your journal on this question between M. A. Shapovalov and I. I. Korobov.

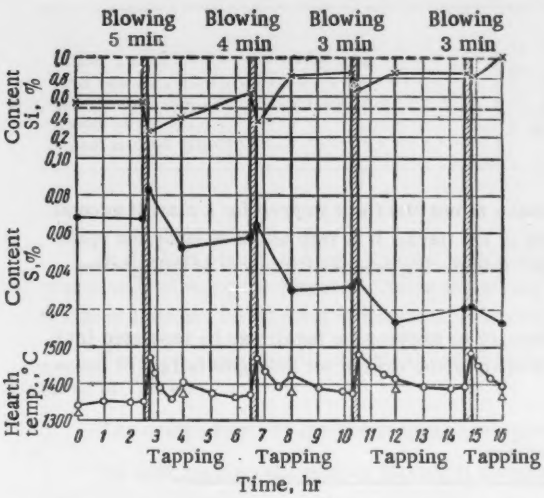
Unfortunately, I have not yet been able to acquaint myself with the article by I. I. Korobov, "On the reduction in the sulfur content of pig iron in the blast-furnace process", or with all the data of the discussion. Since, however, the question of iron smelting with supply of oxygen to the blast-furnace hearth is under discussion, I should like to refer to a statement by M. A. Shapovalov, to which I cannot refrain from replying.

In his article, M. A. Shapovalov says: "The supposition made by I. I. Korobov to the effect that by supplying oxygen to the blast-furnace hearth, it will be possible to increase the temperature of the slag and so improve the desulfurization of the iron is also wrong. The supply of oxygen to the hearth will not increase the temperature of the slag without additional fuel consumption. The supply of oxygen to the molten iron will cause the iron to burn with the liberation of heat, which will produce an increase in the temperature of the slag. At the same time, the slag will become saturated with ferrous oxide, which will impair the desulfurization conditions."

The results of our experiments do not confirm the assertions made by **Shapovalov.** I should, therefore, like to put forward here my own opinion, and I shall be very glad to learn the views of **Shapovalov** and other metallurgists of your country.

I consider that: 1) The supply of oxygen to the blast-furnace hearth increases the ferrous oxide content of the slag, which will accelerate the reduction of sulfur in the molten iron adjacent to the slag, which contains much sulfur; 2) the supply of oxygen will rapidly increase the temperature of the molten iron; 3) the temperature of the slag will also be increased, while its basicity ($CaO : SiO_2$) will attain 1.5 compared with 1.3 in the

normal process, and the viscosity of the slag will be reduced. All this will create favorable conditions for desulfurization.



Variation in composition and temperature of iron when oxygen-blown in the hearth. The triangles denote the tapping temperatures.

Taking the foregoing into account, it will be found that a degree of desulfurization of iron which cannot be attained in the normal blast-furnace smelting process can be obtained not by one oxygen blow but by several such blows.

In this article, I should like to describe the effects of desulfurization by such a method according to the investigations which have been made on the experimental 3-ton blast furnace at Yawata Plant.

As will be seen from the figure, during a four-hour interval between tappings of pig iron from the furnace, oxygen was supplied to the hearth only once for several minutes. Repeated short-time blowing in each interval between tapping enables the sulfur content of the iron to be reduced.

The essence of this process resides in the fact that oxygen is supplied only for a few minutes in 4 hours. Consequently, the unfavorable conditions for the desulfurization of the iron (FeO increase in slag) occur only for a very short time (2% of the total iron-smelting time of the blast furnace). For the remaining 98% of the smelting time, the conditions in the hearth are favorable to desulfurization (high hearth temperature and high slag basicity). In my opinion, this has ensured good desulfurization of the iron – 99.8%.

It should be pointed out that I conducted the investigations only on experimental blast furnaces of small capacity (1-3 t). I am convinced, however, that on an actual large-capacity blast furnace, the method will give a greater effect; although in these conditions, the effect of blowing will not be so marked as in a small furnace, due however to the higher thermal capacity of the furnace of large volume, the temperature in the hearth will be maintained better (even in a small blast furnace, a sufficient temperature can be maintained for 6 hours).

I should like to point out the following advantages of the use of tuyeres for blowing the iron with oxygen in the hearth:

1. It is possible, through the tuyere for blowing oxygen into the hearth, to take samples of molten iron or slag at any time and as convenient (as is done in open-hearth and electric furnaces).

2. It is possible to introduce, through the tuyere, into the molten iron oxidizing and reducing agents and also desulfurizing agents (CaO, CaF_2), and thus regulate the composition of the molten iron in the intervals between tapping.

THE OPERATION OF "FLOATING" COOLERS IN THE STACK OF A LARGE BLAST FURNACE

R. D. Kamenev and M. A. Sukonnik

Krivoi Rog Steel Plant
Translated from Metallurg, No. 1,
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After $17\frac{1}{2}$ months operation the large-capacity blast furnace at our plant was stopped for a class II general overhaul because of the extensive wear in the refractory lining of the stack. It is very useful to study the operating experience with this furnace and to use it in planning and introducing new blast furnaces of still greater capacity in the near future.

The operation of a blast furnace from the moment of blowing to stopping for repair can be separated into two roughly equal periods. This facilitates the study of the conditions and reasons for the rapid failure of the refractory lining and the system for cooling the furnace stack.

TABLE 1. Operation of Large-Volume Blast Furnace

Indices	I period		II period	
	February 1959	March 1959	October 1959	November 1959
Efficiency	0.795	0.804	0.754	0.762
Intensity of smelting, kg/m^3 · days	980	973	1015	993
Content of sinter in charge, %	93.0	89.0	85.0	84.0
Basicity of fluxed sinter	1.02	1.02	1.01	1.03
Content of Fe in fluxed sinter, %	47.4	47.0	47.0	47.7
Content of Fe in charge, %	41.6	40.0	41.1	43.7
Blast:				
feed, m^3/min	3519	3670	3332	3325
temperature, °C	902	939	893	894
pressure, atm gauge	2.42	2.43	2.43	2.47
humidity, g/m^3 (STP)	41.3	42.4	40.0	40.2
Blast-furnace gas:				
temperature, °C	412	416	393	407
pressure, mm water column	11617	11742	11452	11457
content of CO_2, %	14.4	14.3	14.2	14.7
Yield of slag, kg/ton iron	777	935	845	893
Dust removal (total), kg/ton iron	67	103	100	39
Consumption for 1 ton of iron, kg:				
iron ore and sinter	2044	2134	2075	2057
manganese ore	52	60	6	13
metal additions	–	–	–	–
limestone (raw)	251	344	330	343
coke (dry)	719	764	765	743
Composition of iron:				
Si	0.51	0.61	0.74	0.74
Mn	1.3	1.31	1.49	1.49
S	0.041	0.042	0.045	0.045
P	0.104	0.110	1.101	0.101

TABLE 2. Chemical Analysis of Raw Materials

Material	SiO_2	Al_2O_3	CaO	MgO	FeO	Fe_2O_3	Fe	Mn	S	P
Sinter	14.0	2.54	14.1	0.81	9.5	56.6	47.0	1.58	0.051	0.053
Iron ore	23.0	3.90	0.20	0.31	1.4	70.6	50.5	—	0.026	0.046
Manganese ore	27.7	2.38	4.1	1.31	—	5.0	3.5	27.7	0.030	0.153
Limestone	0.9	0.74	53.8	1.14	—	1.94	1.36	—	0.027	0.013
Dolomitized limestone	0.46	0.80	41.8	9.9	—	1.94	1.36	—	0.045	0.017

In the first period, lasting 8 months, experience was gained with the equipment and the technological system after blowing the furnace. During the second period, lasting 9½ months, the maximum productivity was achieved from the furnace but at the same time there was rapid wear in the refractory lining.

The most characteristic technical and economic indices for the furnace operation during these periods are given in Table 1.

The compositions of the raw materials are given in Table 2.

We will consider the reasons making it necessary to repair the blast furnace.

The bottom cylindrical portion and the stack were cooled, in accordance with the plan, by horizontal floating coolers (24 coolers in a row), placed in the lining at a distance of 345 mm from the line of the construction profile of the blast furnace. In all there were 16 rows of floating coolers placed immediately on the lining without breasts and the tubes were welded to the jacket.

Up to the moment of blowing out the furnace for repair 154 floating coolers were disconnected. Intensive failure began 8 months after blowing-in. The coolers which failed were above the iron and slag tapping holes. The number of disconnected coolers for the various months is shown in Fig. 1.

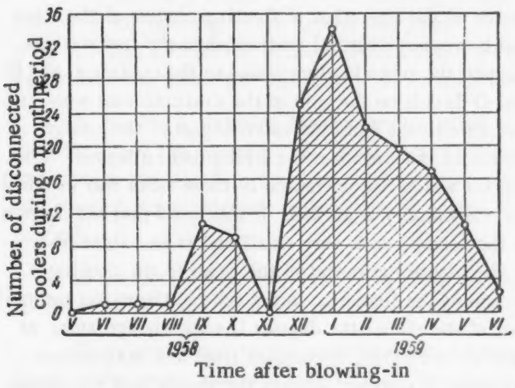

Fig. 1. Number of disconnected coolers for various months.

The failure of coolers in the bottom cylindrical portion and the stack caused large amounts of water to form in the region of the iron tapping hole as a result of which both tapping hole coolers and the frame of the tapping hole were burnt. The premature wear of both elements is also due to design faults in the main spout-insufficient slope and length of the spout meant that the molten smelting products could not be rapidly removed from the tapping hole case during tapping.

The thickness of the remaining refractory lining was measured after blowing out the furnace for repair. The results of the measurements are given in Fig. 2. As can be seen from Fig. 2, the erosion of the lining is one-sided, mainly in the region over the iron and slag tapping holes from the center of the stack to the bottom cylindrical portion, i.e.,in the zone of the failed coolers.

The top of the stack above the I level was in a good state over the whole of the perimeter (thickness of lining 750-850 mm). Below this level the lining is intensively eroded over the iron tapping hole. Between the I and II levels the thickness of the lining in this region does not exceed 150 mm, and over the remaining part of the perimeter of the furnace it is reduced in thickness by 50-150 mm and is maintained within 700-750 mm over the whole height.

Below the II level (at a level of 19000 mm over the iron tapping hole) between the tuyeres No. 4 and 16 about 400-500 mm of the lining was not complete. The area of the guard plate of the stack not protected by lining was about 30%. In this region the jacket of the stack was buckled.

After raking out the residues of the charge and the fallen refractory lining from the hearth the lining of the bosh and hearth up to the level of the slag tapping holes was inspected. There was no lining in the region of the bosh; however the state of the plate coolers was still good. The lining of the hearth was in a good state and was protected by hardened slag the thickness of which on the level of the tuyeres was 350-500 mm.

The floating coolers were also missing in the stack and bottom cylindrical portion on the side of the iron and slag tapping holes where there was no refractory lining. Judging by the external appearance of the ends of the cooler tubes left on the inside of the guard plates it might be supposed that the large-scale failure was due to tearing of the tubes at the guard plates during movement of the refractory lining. If the reason for the failure of the coolers was their burning, it would take place gradually and nonuniformly; near the jacket there would be coolers and tubes of different length and also residues of refractory linings. Furthermore, the coolers would have burnt round the whole periphery of the furnace and not only over the iron and slag tapping holes. In addition, the erosion contours around the periphery of the stack show a sharp transition from the remaining lining to a complete lack of it, which also supports the assumption of the tearing of floating coolers over the iron and slag tapping holes.

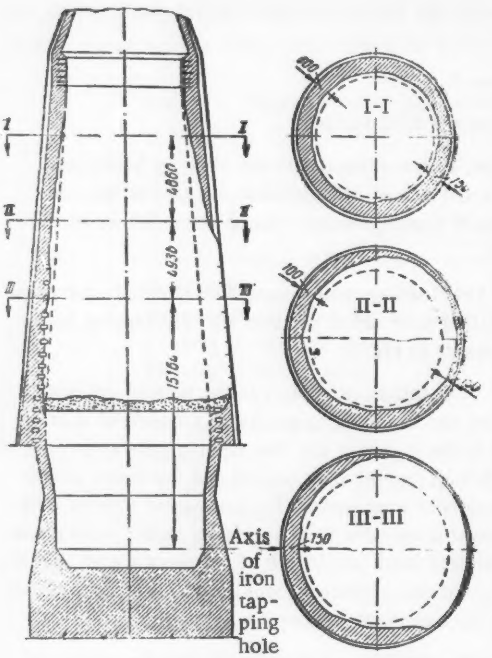

Fig. 2. Wear of the lining of a furnace stack before repair.

This is confirmed by the simultaneous collapse of several coolers placed under one another in neighboring rows. Cases of simultaneous collapse of coolers were fairly frequent.

The lining of the stack and bottom cylindrical portion on the side of the air heaters was in good condition, the coolers projected from the lining in the upper levels by not more than 100 mm, in the bottom levels – up to 200 mm. The lining in this region was so monolithic that it did not fail after a series of impacts.

Under the conditions of the Krivoi Rog Steel Plant the reason for the burning of the coolers is often the poor quality of water, especially with uncontrolled washing of the coolers. In order to determine the effect of this factor on the operation of floating coolers of the stack and bottom cylindrical portion when the furnace was stopped the tubes leading water to the coolers at the II and IV levels on the side of the dustcollector were cut, and also a tube from the internal part of the cooler, chosen at random after the lining had collapsed. The deposit which had collected in these tubes was weighed and chemically analyzed. It was found that the deposit in the feed pipes is very small and is an oxidation product from the metal of the tubes in the cooling system of the furnace. In the tube cut from the internal part of the cooler the deposit is somewhat greater; as well as iron oxide, it contains lime and magnesium. However, it does not support the theory that the reason for failure in the floating coolers of the stack and bottom cylindrical portion is the poor quality of the water.

To find how the character of distribution of materials at the upper cylindrical portion affects the one-sided erosion of the stack lining, the protective segments of the upper cylindrical portion and the charging system were inspected.

The protective segments of the upper cylindrical portion were in good condition. Around the periphery of the protective segments there was no section which was worn to a greater extent than the others. The large bell and the bowl, which operated at a gas pressure under the upper cylindrical portion of 1.20-1.35 atm gauge for 17½ months, were in a satisfactory condition and were suitable for further use. This points to the normal operation of the charging system.

It was, therefore, concluded that the most probable reason for the failure of the lining is the incorrect design of the floating coolers of the stack and bottom cylindrical portion of the furnace. The faster convergence of materials over the iron and slag tapping holes leads to a somewhat greater wear of the lining in this region. Since the floating coolers rest on the lining, several coolers were torn, which then led to further breaking of the lining and collapse of the coolers in this region.

During the furnace repair the floating coolers of the stack and the bottom cylindrical portion were replaced by vertical plate coolers with cast brick. In addition, two rows of "cantilever" type coolers were placed over them.

Editorial Note. In publishing this article by R. D. Kamenev and M. A. Sukonnik, the editor would like to point out that the premature wear of a large-capacity blast furnace stack lining is not only due to the design of the coolers but also to technological reasons.

AT THE YUGOK SINTERING PLANTS

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Translated from Metallurg, No. 1,
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The method for sealing the openings of hoppers, used up till now at the YuGOK Sintering Plants, by covering them with rubber belts has not satisfied operating requirements: after the discharging trolley had passed, the belts did not usually lie on the previous place.

The openings of the hoppers containing ground limestone are now tightly closed. The old conveyer belt is placed on the opening of the hopper and passes through four rollers placed on the chute of the discharging trolley (Fig. 1). The ends of the belt are fixed. When the discharging trolley moves, the belt is stretched in the rollers. Experience has shown that this device for sealing the bunker openings works efficiently.

At the No. 1 sintering plant a large amount of dust was liberated when it was unloaded from the multicyclone bins. The intention of the plan was to unload this dust onto the conveyers by worm conveyers; however attempts to moisten it in the worms did not give satisfactory results. The moistened dust stuck and after the worm had stopped it was difficult to get it going again. The dust content in the multicyclone building was 2200-3400 mg/m^3.

In the plan for the No. 2 sintering plant the dust was removed from the multicyclone binsby a hydraulic method. After some time this method was also adopted at the No. 1 plant.

To deliver water to the water seals on the multicyclone hoppers the plan includes feed tanks. The water level in the water seals was indicated by floating valves in each supply tank. However, these valves often failed and, therefore, the supply tanks were replaced by water collectors into which water was fed from a pipe, and then directed into the water seals of the multicyclone dust bins.*

At the present time the dust content of the air in the multicyclone buildings of the No. 1 and 2 sintering plants is 1.5-1.8 mg/m^3, i.e.,it does not exceed the hygiene standard.

The sintering machines have covers except for the sections at the hearths which are left open so that the sintering process can be observed. The idle branch of each sintering machine is also in a cover. Unfortunately, the sintering machine covers made at the combine are not sufficiently effective, due to poor sealing. The removable side plates and the body of the cover are joined together loosely, so that air is drawn from the building

* This arrangement was used at the "Zaporozhstal'" Plant (Metallurg, 1960, No. 9).

into the cover; sealing the leaks is not an easy matter. However, the amount of dusty air drawn into the sintering sections from the roof and from other buildings has been reduced after the installation of covers. The dust content of the air at the working places of the sintering plant workers, which previously varied between 33.4 and 6.7 mg/m^3 is now 8.5-1.5 mg/m^3.

Water-cooled screens of metal mesh have been installed at the hearths of the sintering machines. This has reduced the intensity of heat radiation at the working places by 6-7-fold.

When the material falls into the return hopper an excess air pressure is set up, due to which a large amount of dust collects in the space under the hopper. The return hopper is now fitted with exhaust pipes connected to the exhaust pipes of the unloading part of the sintering machines and the dust disturbance has stopped.

When the finished sinter is loaded into the hoppers a large amount of dust is again set free. Previously it fell into the sintering plant body or was scattered over the surrounding territory. Therefore, at the No. 1 sintering plant each reversible spout was covered at the top by a metal plate (Fig. 2) fixed on a hinge. When the spout was tilted the plate moved along the guides along the top of the stationary spout, which made it possible to reduce the scattering of dust by the wind when the dust was liberated during loading. There was an increase in the amount of air drawn through the unloading spouts into the cover of the sintering machines. At the combine it is intended to place canopies over the hoppers through which dusty air will be drawn away.

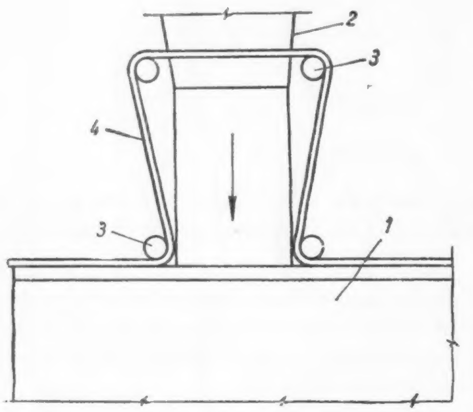

Fig. 1. Sealing loading opening of bin: 1) bin; 2) spout of discharge trolley; 3) rollers; 4) belt.

In the return galleries of the sintering plants there was intensive fog formation. In the plan the return conveyers of the No. 1 sintering plant were covered with small-capacity metal covers. In the horizontal part of the gallery the air from the covers was removed through exhaust shafts and in the tilted part the steam and moisture were removed through the shaft with deflectors placed along the whole length of the conveyer. The air flow was directed through perforated air pipes into the bottom part of the gallery. However, due to the insufficient capacity the covers of the return conveyers were strongly heated; furthermore, there were difficulties in collecting the waste from the conveyers. The doors in the covers, suspended on side loops, were usually open and hindered passage between the conveyers.

Air was not removed from the conveyer covers through the deflectors placed in the bottom part of the galleries but on the contrary it was brought there under the action of the natural draft into the gallery. This increased the intensity of fog formation. Because of these faults, the small-capacity covers of the return conveyers were dismantled. The capacity of the covers in the horizontal parts of the gallery was considerably increased.

Under the sealing in the inclined galleries between the conveyers a perforated air pipe was laid along the whole length of the gallery and hot air fed through it (Fig. 3). Removable metal curtains were hung on both sides of the air pipe. The air from the gallery is removed through two shafts placed in the highest part of the gallery. The visibility in the passage between the conveyers is satisfactory when air heated to 22-27° is fed through the air pipe at a rate of 700 m^3/hr per 1 m of gallery. Fog is, nevertheless, formed over them and at the side guards of the gallery at low temperatures of the outside air.

The floors and walls of the sintering plant buildings are periodically washed with water. Rubber covers are placed over the distribution boxes to prevent the electrical system from being damaged during this operation. The walls are waterproofed by whitewashing with special solutions containing 10% water glass; the resulting coating can withstand up to twenty washes of water from the hose.

In the sintering section and in the building for the gas mains during the washing of the floors and walls the pulp is removed through pans built in the floors and covered with grids. The pulp from the water seals of the multicyclone dust bins is also directed through the pans into the sludge settler. The pans are washed periodically with water from tanks with siphons so that they do not become choked up.

The territory of the factory is planted with trees. Along the roadways there are waterpipes which deliver water during the summer to wash the dust which settles on the roads and to water the greenery. There is a special dust ventilation service; at each factory there is a section for ventilation and industrial hygiene, manned by two teams—a ventilation team (seven men) and an industrial hygiene team (ten men). These teams carry out preventive repairs of the ventilation and industrial hygiene equipment.

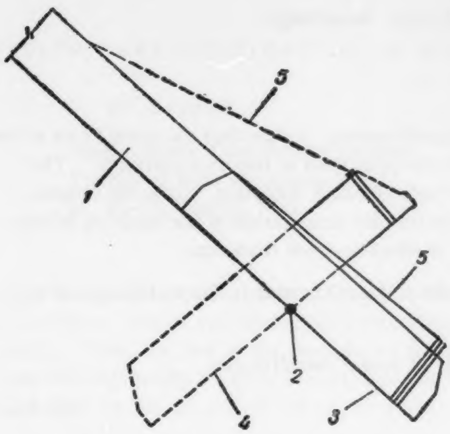

Fig. 2. Sealing reversible spout of unloading part of the sintering machine: 1) stationary spout; 2) axis of rotation of the reversible spout; 3 and 4) different positions of the reversible spout; 5) plate covering the top of the reversible spout.

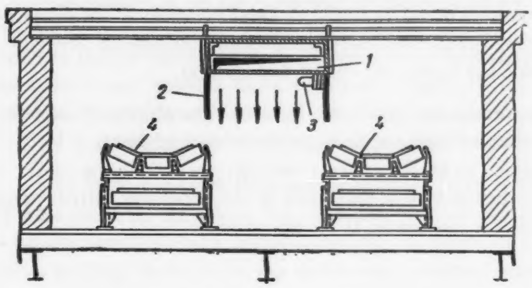

Fig. 3. Air flow pipe into return gallery: 1) air pipe; 2) metal curtain; 3) lamp; 4) conveyers.

In the central chemical laboratory of the combine there is a special group which takes samples from the production buildings to find the dust and air content on the orders of the head of the dust ventilation service. By way of a check, the City Sanitation and Health Station determines the dust content of the air once a quarter.

Experience in combating production difficulties at the YuGOK Sintering Plants leads to the following conclusions.

The sintering and transport equipment should be supplied by the makers complete with the necessary equipment designed to give hygiene protection. Thus, sintering machines, plate feeders, and other equipment should be supplied complete with covers. The covers made at the sintering plants are usually bulky, are not properly sealed, and often do not fulfill the requirements of the operators.

When pyrite cinders containing sulfur are added to the charge, the covers and the ventilation equipment are strongly corroded under the action of sulfur compounds. Sintering plants which process pyrite cinders should, therefore, be supplied with extra metal to replace the worn hygiene protection devices.

A large amount of dust is formed when the finished sinter is loaded into the hoppers. Equipment must be developed to prevent dust formation during this process. The electrical equipment included in the sintering plant plan does not usually allow for the washing of walls and floors. Moisture-resistant electrical equipment must be made and there must be appropriate water insulation of the walls and floors. The sintering plants must be supplied with spare parts for the ventilators,which often fail; the combine is unable to supply these spare parts.

The amount of dust thrown out through the smokestacks of the sintering plants exceeds the hygiene standard. Improvements must be made in the system for removing dust from the gas drawn out by the extractors.

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p. 12, January, 1961

R. Durrer, The Metallurgical Treatment of Iron Ores. Translation from the German by E. F. Wegman, edited by A. N. Pokhvisnev. Moscow, Metallurgy Press, 1960, 176 pages.

The book by Professor R. Durrer is intended for a wide circle of readers. It describes the main forms of raw material and fuel used in the treatment of ores, deals briefly with the principles of ferrous metallurgy. The author then considers possible methods for treating iron ores: methods of direct reduction, producing blooms, producing iron in blast furnaces and electric blast furnaces. There are also descriptions of the smelting of ore-coal briquets in low-shaft furnaces and other interesting methods of obtaining iron from ores.

In the concluding chapter the book deals with the possibilities for development in the metallurgical treatment of iron ores.

R. Durrer's book will be of definite interest for a wide circle of Soviet metallurgists.

A. G.

M. Ya. Ostroukhov, Coke Economies in Blast Furnace Smelting. Moscow, Metallurgy Press, 1960, 144 pages.

The first chapter of the book deals with methods for calculating the amount of fuel needed for blast furnace smelting. It is mentioned that the most interesting are methods based on zonal thermal balances of the furnace; however these methods are not always convenient since they involve arbitrary temperature boundaries between the zones. Calculations based on the total thermal balance are more convenient and simpler.

The author later deals with the effect of various factors on the coke consumption. The effects of the raw material conditions and the parameters of the system on the fuel consumption are considered in detail. In Chapter III ways are shown for reducing the coke consumption in blast furnace smelting: increasing the blast temperature, improving the preparation of the charge and distribution of materials in the upper cylindrical portion. The possibility is also considered of using noncoking coals as a raw material for blast furnace fuels.

The book is intended for engineers, technicians, and scientists.

A. G.

PRELIMINARY DEOXIDATION OF TUBE STEELS

V. K. Laptev

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In steel production, there are many methods of preliminarily deoxidizing metal in the furnace. In essence, each factory uses its own deoxidation technique and, in the prescribed conditions, obtains metal of satisfactory quality. Thus, the cost of the deoxidation method adopted frequently is not calculated. At the Azerbaidzhan Tube-Rolling Factory we have investigated the effect of several different methods of preliminarily deoxidizing tube steel (St. 10, 20, 35, 45, D) on the quality of the metal and its cost.*

The experimental melts were made by the scrap process using a solid charge in entirely basic single-spout open-hearth furnaces fired with natural gas with fuel oil carburetion.

Preliminary deoxidation, according to the technical instruction, was carried out by two different methods (let us call them methods I and II).

In method I, ferromanganese was introduced into the furnace, and then after a short holding period, 12% ferrosilicon.

In method II, on the contrary, first of all 12% ferrosilicon was added in the furnace and after a short holding period, ferromanganese. In all the methods, deoxidation in the ladle was carried out with 45% ferrosilicon. In order to reduce the consumption of deoxidants and to save time, two further different methods of deoxidation were tried out: method III for tube steel types 35, 45, D (deoxidation carried out by the simultaneous addition of blast-furnace ferrosilicon and ferromanganese in the ladle) and method IV for steel types 2, 3, 10, 20 (deoxidation carried out in the furnace with ferromanganese alone).

In method III, the steel was deoxidized in the following sequence: when the carbon content reached the middle point for the given type of steel, 12% ferrosilicon and ferromanganese were introduced into the furnace with one charging-pan; ferromanganese was added at a rate to give the lower limit of the manganese content. After holding for 5-7 min, the metal was poured.

In method IV, when a carbon content 0.03-0.05% above the middle point for the given type of steel was reached, ferromanganese was introduced into the furnace at a rate to obtain a manganese content at the upper limit. In 5-7 min the melt was poured. In the ladle, correction of the manganese content was carried out, and also deoxidation with 45% ferrosilicon and aluminum.

The metal was bottom-poured in accordance with the existing technical instruction with a wooden box on the surface of the rising metal. The quality of the metal was checked in the rolling shop on the finishing section of mill 850. From the tube billets samples were taken for micro- and macro-examination.

In assessing any deoxidation method, the loss and consumption of deoxidants per ton of steel smelted play an important role. For comparison, 20 melts were smelted according to method I and 20 according to method II.

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* The work was carried out by Engineers V. K. Laptev, D. S. Brazaluk, P. P. Podgornii, with the assistance of Engineers A. F. Borsh, B. I. Podzharskii, I. A. Vinokurov, S. É. Barkan, A. F. Lysukhina, Technicians T. K. Khateeva and L. I. Arbitman.

As can be seen from Table 1, the manganese loss in methods I and II was more or less identical for both soft and medium-carbon steels. In deoxidation with method III, the manganese loss was 9% lower, and in deoxidation with method IV approximately 8% lower than with methods I and II.

TABLE 1. Cost and Loss of Deoxidants in Deoxidizing with Different Methods

Characteristic	Method I		Method II		Method III	Method IV
Type of steel	10–20	35, 45, D	10–20	35, 45, D	35, 45, D	2, 3, 10, 20
Number of melts . .	10	10	10	10	7	10
Manganese loss, %	44.8	27.4	43.0	27.3	18.0	52.6
Consumption of ferromanganese, kg/ton	4.35	5.3	3.51	4.22	3.7	3.9
Silicon loss, %	29.6	31.8	30.9	26.8	28.3	30.9
Consumption of 12% ferrosilicon, kg/ton	12.23	13.8	12.3	14.6	13.0	—
Consumption of 45% ferrosilicon, kg/ton	4.81	4.9	4.9	4.7	4.7	6.8
Cost of deoxidants*, rubles/ton of steel	13.81	15.63	12.00	14.45	13.00	8.66

* Without aluminum, which is added in the ladle (the cost of deoxidants in the table and in the article is given in 1960 prices).

It is interesting to note that the consumption of ferromanganese in deoxidizing soft steels by method IV is lower than by method I; it was 3.9 kg/ton. This is explained by the fact that the furnaces are worked hot and the manganese content before deoxidation reaches up to 0.30-0.35%; therefore, not much ferromanganese has to be added in the furnace.

For hard steels, the consumption of ferromanganese was very low in deoxidizing with method III (3.7 kg/ton).

The silicon losses (including also 45% ferrosilicon) in all the deoxidation methods were almost identical. The consumption of 12% ferrosilicon for medium carbon steels in method III was somewhat lower than in methods I and II. The consumption of 45% ferrosilicon for soft steels in method IV was higher by 1-2 kg per ton of steel. The cost of deoxidation of one ton of metal (not taking account of aluminum) was lower for method III than for method I by about 2 rubles, and for method IV than for method I by 5 rubles 15 kopeks.

In the deoxidation of steel with method IV the carbon content of the steel should be 0.03-0.05% higher than in deoxidation with method I; this exerts a considerable effect on the melt duration in the production of low-carbon steel. The time in finishing is reduced by about 15 min, and the duration of the whole melt by 3%. By doing away with deoxidation in the furnace with silicon, one reduces the amount of phosphorus which is restored from the slag during deoxidation.

Deoxidation with method III is shortened by about 5 min, and phosphorus restoration from the slag thus hardly occurs. It is made considerably easier to obtain metal with the specified carbon content, especially for medium-carbon steels.

Examination of blooms on the finishing section of mill 850, deoxidized with all four methods, did not show any essential difference in the external defects. In individual melts cracks and fireclay inclusions were discovered. These defects do not appear to be typical of any particular deoxidation method and depend entirely on the pouring conditions (temperature and rate of pouring, the cleanness with which the ladles, spouts and casting compounds were prepared) and on the heating and rolling of the metal.

In the cold finishing section of the tube-rolling shop, tubes are inspected, scrapped, and samples selected for mechanical tests (determination of UTS and percentage elongation).

As it follows from Table 2, the yield of grade I tubes was higher in melts deoxidized by methods III and IV; moreover, in these melts, there was less second grade and scrap. The mechanical property indices of soft steel tubes for all the deoxidation methods are approximately identical (UTS 43.0-46.0 kg/mm^2).

For hard steels, the UTS was higher in steels the metal of which had been deoxidized by method III (65.2 kg/mm^2). The percentage elongation differs little in deoxidizing metal with all the methods.

Sections for macroanalysis, taken from billets of tube metal, were subjected to deep etching. After inspection of the sections it was established that the percentage relationship between satisfactory and unsatisfactory macrostructures in sections taken from metal deoxidized according to the different methods was almost identical.

Determination of the contamination of the steel with non-metallic inclusions (according to the TsNIIChM – Central Scientific-Research Institute for Ferrous Metallurgy – scale of steel contamination) indicated that, in deoxidizing the metal with the different methods, a marked difference in the contamination of the steel with oxide inclusions was not found. A somewhat increased contamination of the steel with sulfide inclusions in the separate melts was found in deoxidation with method III; the over-all index for sulfides was, therefore, 3.5. Metal deoxidized by method IV had a very low sulfide inclusion index.

TABLE 2. Yield of Different Grades and Tube Mechanical Properties

Deoxidation method	Steel	Grade I, %	Class II %	Grade II, %	Rejects, %	C + 0.25 Mn content in metal, %	Mechanical properties: UTS σ_B, kg/mm²	Mechanical properties: relative elongation δ, %
I	Soft	91.75	5.05	3.2.	0.33	0.27	48.3	23.6
	Hard	89.3	9.7	1.0	—	0.58	49.7	15.0
II	Soft	91.3	5.6	3.1	0.23	0.27	46.0	23.6
	Hard	94.0	3.25	2.75	0.2	0.61	56.7	16.2
III	Hard	97.4	1.82	0.78	0.06	0.59	65.2	16.7
IV	Soft	94.5	5.1	0.4	0.1	0.27	42.5	21

From the literature it is well-known that the sequence of introducing 12% ferrosilicon and ferromanganese for the preliminary deoxidation of killed steel has effect neither on the oxygen nor on the non-metallic inclusion content, nor also on the mechanical properties of the metal.

In this way, metal deoxidized in the furnace with ferromanganese alone is cleaner, as regards the number of oxides, sulfides, and silicates, than metal deoxidized by the usual technique. From what has been presented above, the following conclusions may be made:

1) As well as the generally adopted method of preliminarily deoxidizing tube steels, the deoxidation may also be carried out in the furnace with ferromanganese alone or simultaneously with ferromanganese and 12% ferrosilicon.

2) In deoxidizing metal with ferromanganese alone, the duration of the process is shortened by 15 min, and the whole melt by up to 3%. In the simultaneous introduction of the deoxidants into the furnace, deoxidation is reduced by 5 min.

3) With deoxidation in the furnace by ferromanganese alone, the other conditions of carrying out the melt being the same, the phosphorus content in the finished steel is lower than in deoxidizing with 12% ferrosilicon.

4) The cost of manufacture of steel deoxidized in the furnace with ferromanganese alone is lower by 5 rubles 15 kopeks per ton than that of steel deoxidized by method I.

THE USE OF STEAM FOR BOOSTING COMBUSTION IN OPEN-HEARTH FURNACES

Antonin Bikhler

Head of Technical Branch of Trzhinetsk Metallurgical Plant, Czechoslovakia
Translated from Metallurg, No. 1, pp. 15-16, January, 1961

To boost gas combustion in open-hearth furnaces, up till now only compressed air or oxygen has been used. However, in the literature it has been repeatedly pointed out that for this purpose it is possible to introduce small amounts of water or superheated steam into the mixture of gas and air.

On the basis of these statements, for the first time in the world a superheated steam supply into the flame of an open-hearth furnace was tried out at the Trzhinetsk Metallurgical Plant in 1955. Steam at the rate of about 1 ton/hr was supplied into the flame of a 150-ton-capacity tilting open-hearth furnace with a Dinas (silica) roof. The steam temperature was about 250° C and the pressure approximately 20 atm. The first tests showed that the combustion process was considerably intensified and the production capacity of the furnace raised. However, during the trial melts increased wear on the furnace refractories was observed. A furnace was, therefore, chosen for the trials which would have to be shut down for repair in a few melts' time.

On the basis of experience of these first melts, the use of steam in 200-ton stationary open-hearth furnaces with magnesite-chrome roofs was begun; these were fired with a mixture of blast-furnace gas and coke-oven gas with carburetion of the flame with tar. A diagram of the steam supply to the furnace is shown in the figure.

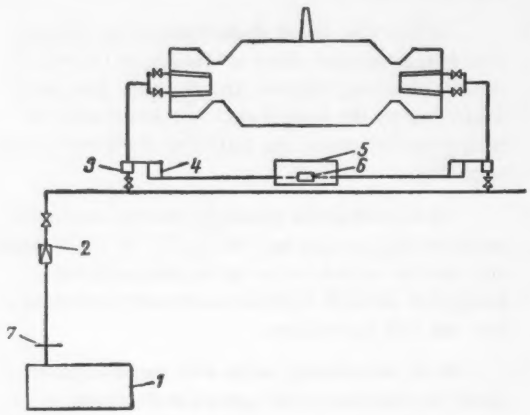

Diagram of steam pipe-line to open-hearth furnaces. 1) Boiler; 2) reduction valve; 3) butterfly valve; 4) electromagnet; 5) control panel; 6) electrical change-over switch for the electromagnets of the change-over installation; 7) metering diaphragm.

The total steam consumption in the open-hearth furnace is measured by the yield from the boiler, where the pressure reaches 20 atm. Before entering the 80 mm diameter pipe-line, the steam pressure is reduced to 12 atm. From the main pipe-line, a 60 mm diameter pipe-line goes off to each side of the furnace, which is provided with a locking cock and butterfly valve. The steam is supplied into the caisson by two tubes 1 inch in diameter, each of which ends in a 10 mm diameter Laval's nozzle. The butterfly valves are driven through a lever arrangement by electromagnets which are switched on from a control panel. After switching over, the steam is not cut off entirely, but its pressure is reduced only to about 2 atm in order to protect the nozzle from clogging. Steam consumption is 0.7-1.3 tons/hour at a pressure of 8-10 atm and a temperature of 250-300° C. In the future the supply of steam is to be markedly increased.

The use of steam has made it possible to increase the production capacity of the furnace considerably. A comparison of the working of furnaces with and without the use of steam shows that the maximum increase in production capacity is found in the first half of the campaign. On average, the hourly furnace production capacity is increased by 2.6% during the campaign, during which the steam consumption is reduced from 1.3 tons/hr to 0.7 tons/hr. In supplying steam at 1.3 tons/hr the production capacity was 6.7% higher than in working without it. The optimum steam consumption has not yet been established.

To determine the effect of steam on fuel consumption, two successive campaigns on the same furnace were compared. It was thus ascertained that the specific consumption of ideal fuel was reduced from 158 to 154.6 kg/ton (including, also, the fuel consumption in the casting bay), that is, by 2.17%.

Since the durations of the campaigns were different—the campaign without the use of steam lasted 336 melts, and with steam 355 melts—both campaigns were also compared up to and including 336 melts. The specific fuel consumption calculated by this method was reduced from 158 to 152.8 kg/ton, that is, by 3.25%. From this it can be seen that the saving in fuel is reduced toward the end of the campaign.

During the trials the effect of steam on the consumption of iron ore was also ascertained. Experience showed that, other things being equal, the consumption of iron ore to obtain the identical carbon content at meltdown was reduced with the use of steam. The FeO content in the slag is higher in furnaces working with the use of steam, the consumption of ore is reduced by 7.60%, and the life of the furnace roof not reduced.

In the open-hearth furnaces in our factory, rimming carbon steel for deep-drawing is smelted. Clearly, how steam affects the content of harmful impurities in the metal and the mechanical properties of the finished steel are of interest to us. Investigations have shown that the sulfur content in metal from melts made with the

use of steam is not higher than in ordinary steel. The rate of desulfurization is greater in melts with the use of steam than in ordinary melts.

Supplying steam to the flame contributes to the better removal of phosphorus from the metal.

Before the use of steam had been started, there had been fears that it would increase the hydrogen content of the steel. Therefore, a comparison was made between two melts smelted with steam, and a melt carried out without a steam supply. The results of the comparison showed that steam only increased the hydrogen content in the steel very slightly (by 0.67 g/100 cm^3). This result, in general, accords with data in the literature.*

The effect of steam supply on the technical properties of soft rimming steel for deep drawing was also investigated. The capacity of the sheet for drawing, its stratification, content of non-metallic inclusions and blowholes, and also its elongation turned out to be fully satisfactory. This is also true for hard killed steel and alloy steel.

Thus, it may be concluded that boosting oil combustion with superheated steam raises the production capacity of open-hearth furnaces without impairing the quality of the metal. This method can be recommended for use in open-hearth furnaces.

FLUSHING THE CHECKERWORK OF LARGE-CAPACITY OPEN-HEARTH FURNACES

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Magnitogorsk Metallurgical Combine
Translated from Metallurg, No. 1, pp. 17-18, January, 1961

Between repairs the operation of the open-hearth furnace is characterized by fluctuations in the length of the melting period and in the magnitude of the unit heat consumption. The prolongation of the heat and the increase in unit heat consumption are especially noticeable toward the end of a campaign, when "aging" of the furnace takes place due to corrosion of the masonry and a consequent loss of heat and also to choking of the heating surfaces in the checkers by molten spray, which reduces the extent of heat exchange in them and increases the pressure in the combustion space.

One of the effective methods for smoothing the irregularity in the operation of the open-hearth furnace is to clean the spray from the heating surfaces of the checkerwork.

In the Magnitogorsk Metallurgical Combine, water supplied at a pressure of about 2.0 atm has been used for cleaning molten spray from the heating surfaces of the checkerwork of the regenerator.†

To increase the water pressure a centrifugal pump has been installed which supplies 50 cubic meters of water per hour at a pressure of 20 atm (the rating of the electric motor is 55 kw, 1470 rpm). A pipe 2 inches in diameter has been laid from the pump along the entire open-hearth plant, and pipes $1\frac{1}{2}$ inches in diameter lead to each regenerative chamber. The checkerwork is flushed with the aid of a nozzle-pipe 1 inch in diameter and 8 m long, on the end of which is mounted a collar with a 12 mm interior diameter.

The nozzle is connected with the feeder pipe by a rubber hose 1 inch in diameter and 10 m long. The water pressure against the nozzle is maintained by a spring manometer.

* Metallurg, 1959, No. 3.

† The top of the regenerator chamber is made of high-alumina bricks according to the pattern of Peterson.

While flushing the checkerwork, the water pressure at the nozzle is kept in the range of 10-12 atm by diverting a part of the water to an overflow sump.

The checkerwork of the open-hearth is flushed every 20-25 heats according to a chart which is constructed each month and registers the age and condition of the furnace. Flushing is begun after 40-50 heats following each repair. During the last 50-60 heats (before repair), flushing is done oftener and depends on the rate of accumulation of molten spray on the checkerwork.

The checkers are flushed during all periods of the heat while the combustion gases are passing through the regenerator. The flushing of a single regenerator chamber takes 15-25 minutes and uses 3000-5000 liters of water supplied at a flow rate of 200-250 liters per minute.

The stream of water impinging upon the slag-covered surface of the bricks sharply lowers their temperature. Slag covering the surface of the regenerator bricks is cooled, breaks up, and is carried beneath the checkers by the water. During the flushing, the temperature at the top of the air regenerator chamber is lowered 50-200°, depending on the stage of the heat, the condition of the regenerator cells, the duration of the flush, and the quantity of water used. Normal chamber temperature is regained within 15-20 min after flushing is completed.

Since the thermal condition at the top and bottom of the furnace changes continuously, no sharp change in the temperature of the preheated air measured in the air uptake is observed. During the flushing of the checkers, the temperature of the combustion gases is lowered 20-100°.

After each flushing the draft in the air regenerator chamber is increased by an average of 2.0 mm water column. This allows a lowering of the pressure in the combustion space which is especially effective toward the end of a furnace campaign.

Flushing the checkerwork also permits the performance of the open-hearth furnace to be improved in case the temperature in the regenerators drops off due to an increased resistance in one of them resulting from dust accumulation. The 400-ton open-hearth furnace was operating with a large temperature drop in the air regenerator chambers; the temperature of the right chamber during the course of several days was 120-150° lower than the temperature of the left one. The draft in the right chamber was 3.0 mm water column lower than in the left. Two hours after flushing the right chamber of the air regenerator, the temperature of the chambers evened out; the operation of the open-hearth became more satisfactory.

A comparative analysis has shown that by flushing the checkerwork, open-hearth furnaces operate more smoothly during the entire campaign.

Observations made on the open-hearth furnaces of the Magnitogorsk Metallurgical Combine revealed that in firing the furnaces, with a mixed gas in the ordinary manner and with natural gas supplied to the usual gas port, the quantity of dust released was less than in furnaces fired with fuel oil.

SUMMARY

1. Flushing the checkerwork of open-hearth furnaces improves their operation. After each flushing the draft above the chambers increases an average of 2.0 mm of water.

2. The irregularity in unit heat consumption during a heat of the open-hearth furnace may be decreased by flushing the checkerwork.

3. The refractories in the regenerators are not ruined by flushing.

4. The process of flushing the checkerwork should be mechanized.

From the editor: The experience of the Magnitogorsk Metallurgical Combine described in the article by M. G. Kozhanov, A. Ya. Raskevich, A. I. Kazakov, and A. M. Kulakov deserves the attention of open-hearth mill workers. However, flushing the regenerator chambers with water does not fully resolve the problem of cleaning molten spray from the checkers. Attention must be given to the furnace regime allowing the least dust, and high-temperature, chemically resistant refractories should be developed. The editor requests readers and specialists to make suggestions and to contribute to the present level of experience with such work in open-hearth mills.

BASIC REFRACTORY WASTES – VALUABLE RAW MATERIAL

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Basic brick wastes form a valuable refractory raw material for the production of different elements of steel furnace linings. However, at a number of steel plants insufficient attention is paid to their use.

At the electric furnaces of the Chelyabinsk Steel Plant the basic brick wastes are used to ram the wall blocks, spouts, to make false altars, and also to dress the slopes, to make mortar and line the lids of annealing furnaces.

The wastes of magnesiochromite and magnesite chrome brick are purified and then ground and then sieved. Their approximate chemical composition is, %:

MgO	Cr_2O_3	CaO	SiO_2	$Al_2O_3 + TiO_2$	Fe_2O_3	FeO	MnO	R_2O
58.8-69.4	9.7-19.4	2.1-4.8	4.6-5.9	1.5-6.0	0.5-3.7	5.0-7.0	0.3-2.1	0.3-0.6

Wall Blocks. The charge for ramming the blocks contains 45-50% of the 15-4 mm fraction and 50-55% of the 4-0 mm fraction.

The charge is heated to 150-160° and mixed with 7.7% (on the average) of molten coal tar pitch. The blocks are rammed in a hot mass by pneumatic rammers in metal templates. These blocks were used to line small- and large-capacity electric furnaces. Tool steels (U7A, 9KhS, etc.) and construction steels (18KhNVA, ShKh15, etc.) were smelted in the low-capacity furnaces; the heats lasted 4-5½ hr ; the temperature of the tapped metal varied between 1560 and 1640°.

The life of blocks from wastes at these furnaces was 75-135 heats; the average life of blocks made from magnesite powder under the same conditions was 70 heats.

Stainless steel 1Kh18N9T was mainly smelted in the large-capacity furnace; the time of the heat varied from 4 hr 40 min to 6 hr 20 min. For a given furnace the life of blocks from wastes was the same as blocks from magnesite powder.

In the lining of the electric furnace walls the blocks made from wastes wore the same as those from magnesiochromite brick – mainly due to shear.

Spouts. The spouts at the low-capacity furnaces were made from charges of two compositions: I) 93-95% wastes and 5-7% titanium magnetite concentrate; II) 85% of wastes and 15% scale.

The grain sizes of experimental charges are given in Table 1.

The charge I was moistened with a solution of green vitriol (density 1.26 g/cm^3); the charge II was moistened with water glass (density 1.46 g/cm^3); the moisture content of the mass was 6 and 6-7% respectively.

The spouts were rammed during the cold repair of the furnaces. A layer of fireclay was placed on the bottom of them (30 mm) and one row of fireclay brick on edge (115 mm); the walls were lined with fireclay of 65 mm thickness. The ramming was carried out manually in layers. Layers of 7-8 mm were rammed to 3-5 mm. The rammed thickness of the bottom was 80 mm, the walls 60 mm. With one man working the ramming of the spout took two hours. One spout needed 380-420 kg of the mass.

On the side of the furnace instead of ramming, two rows of magnesite brick were laid on edge. To prevent the rammed material from sliding during the pouring of the first heats 3-mm iron cut to the shape of the lining was welded to the lip of the spout.

The spouts were dried by gas burners for 4-6 hr.

The life of the rammed spouts of charge I was 149, of charge II–140 heats. The spouts at these furnaces usually withstand 80-100 heats if they are repaired with brick and coated with mortar every heat.

TABLE 1. Grain Sizes of Experimental Charges, %

Charge	Grain size, mm				
	over 5.0	5.0–2.0	2.0–1.0	1.0–0.5	below 0.5
I	4.3	40.2	13.4	15.0	27.1
II	3.1	12.5	12.5	25.3	46.6

The lining of the spout sinters during operation when it comes into contact with the metal. However, the spout is only under the metal for a short time (5 min); therefore, the depth of sintering of the lining is only 7-10 mm. The sintering is somewhat increased when the rammed surface is moistened with water glass.

Due to a sharp change in temperature and mechanical damage during removal of incrustations the sintered working surface of the lining cracks. The break in continuity of the sintered layer leads to crumbling of the underlying unsintered layer. The broken sections of the spouts are restored by a paste with the following composition: 85% of ground wastes of the 2-0 mm fraction, 10% refractory clay, 5% graphite, and 13-15% (above 100) water glass. The thin layer of graphite applied to the lining of the spout protects it from "skull" formation.

Mortar. At one of the low-capacity furnaces the walls were lined with brick using a mixture containing 77% ground wastes of magnesiochromite brick, 15% roasted dolomite, and 8% scale. Water glass was added to the mixture (density 1.2 g/cm^3) to a moisture content of 13-15%.

The grain sizes of the separate components of the mixture are given in Table 2.

TABLE 2. Grain Sizes of Initial Materials, %

Material	Grain size, mm				
	over 2.0	2.0–1.0	1.0–0.5	0.5–0.2	below 0.2
Magnesiochromite wastes	5.4	14.9	29.8	49.9	
Roasted dolomite	15.6	13.0	23.3	16.4	31.7
Scale	5.8	11.1	34.9	23.6	24.6

Mortar was used for a half of the furnace lining. On the slopes two rows of periclase-spinellide brick (PShS-8) were laid on edge; the rest of the lining was made of magnesite. The seam thickness was 5-10 mm. During the process of lining the mortar hardened after 15-20 min.

Observations showed that mortar gives a monolithic lining and protects it from the exceptionally rapid cleaving which occurs in electric furnaces. In the lining made without a paste, after 28 heats chipping took place and some bricks fell out. The experimental lining withstood 239 heats.

The Covers of Annealing Furnaces. Water glass of density 1.40 g/cm^3 is added to a charge containing 90-95% ground wastes of the 2-0 mm fraction and 5-10% of a sintering addition (titanium magnesite concentrate, scale) to bring the moisture content of the mass to 17%. This mixture is applied to the covers, which have been reinforced with metal pins. The thickness of the lining on the cover is 80-90 mm instead of the 130 mm which is used when they are lined with fireclay brick. The covers are dried in air for 4 days.

The operating life of concrete lined covers is 12 weeks instead of the 2-3 weeks when they are lined with fireclay brick.

Ground wastes of the 4-0 mm fraction are used to dress electric furnaces and they can also be used to prepare a pulp to cement the lining of electric furnaces. Wastes with a grain size greater than 15 mm are used for the false altars.

In the separate elements of the lining and also to dress the electric furnaces the department uses all wastes of basic brick after service. The use of wastes in the furnace lining instead of magnesite powder gives considerable economies in the scarce materials and reduces the cost of the metal. In this connection, it would be desirable to have small grinding sections at the steel plants to process basic brick wastes since these constitute a valuable refractory material for electrical metallurgy.

ASBESTOS CURTAINS ON CHARGING MACHINES (INDUSTRIAL SAFETY)

G. Ézenkin

Technical Inspector of Chelyabinsk Regional Council of the Trades Union
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p. 20, January, 1961

The cabins of low-type charging machines such as the UZTM are fitted only with a front window to protect the operator from slag thrown from the furnace.

An analysis of injuries in the open-hearth departments of the Chelyabinsk Steel Plant showed that most burns are sustained by operators of charging machines when the flame is thrown out and reaches the cabin from the sides and through the open slit for the lever of the mechanism which closes the lock of the mold.

To eliminate this danger at the Chelyabinsk Steel Plant the cabin of the operator, as well as the front window, has been fitted at the sides with special curtains of asbestos cloth moving along bars fixed in the upper part of the cabin. When the machine moves along the open-hearth furnaces the curtains open, when it stops at the furnaces and during charging they are drawn; in combination with the front window, this gives the operator the necessary protection against the flame.

The slit of the lever for the mechanism which closes the lock of the mold is periodically sealed with replaceable felt.

The introduction of this measure into low-type charging machines has considerably reduced burns sustained by the operators, but it is not possible to completely prevent the flame entering the cabin of the operator because of the lack of protection at the back of the cabin.

A USEFUL AND NECESSARY BOOK FOR OPEN-HEARTH WORKERS (NEW BOOKS)

A. M. Lekhtik

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p. 20, January, 1961

The removal of slag from the slag pockets of open-hearth furnaces has always been and still is a bottleneck in steel plants. Each plant has its own method for removing the slag, sometimes the methods being entirely unsuitable for the given specific conditions. The shortage of literature on this problem cannot be made up by the articles which appear infrequently in the technical journals. For this reason metallurgists and workers at the specialized repair organizations will be very interested in the book by E. G. Galaton, "The Removal of Slag From the Slag Pockets of Open-Hearth Furnaces" (Metallurgy Press, 1960, Sverdlovsk), which for the first time deals systematically with the whole range of problems connected with the removal of slag from the slag pockets of open-hearth furnaces.

The book discusses in detail the design and the lining of slag pockets, the formation of slags and their physicochemical properties, problems of the deposition of smelting dust as a function of the technological factors, and furnace design.

The author critically considers slag removal methods in Soviet and foreign practice and the mechanisms and equipment used; he gives recommendations for the possible use of a given method, depending on the operating conditions in the department.

The book is a valuable practical manual. It will be very useful to workers at the plants and planning organizations developing improved designs of open-hearth furnaces, in the introduction of productive machines for slag removal. All this will help to increase the useful time of operation of the furnaces and to achieve an increase in steel production.

Unfortunately, the good impression created by the book is somewhat spoiled by careless editing. The editor and proofreader have been inconsistent: the names of foreign firms and machines are written both in Russian and in the foreign transcription, whereas the foreign version is generally accepted in technical literature. The numbers of the foreign journals are shown incorrectly or are entirely absent, there are errors in their titles, and the pages where a given article appears are not shown. The result is that the interested reader will have difficulty in finding material. This careless editing considerably reduces the value of this useful and necessary book.

GROUND STAINLESS STEEL PLATES

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N. A. Troshchenkov, Leader of the Steel-Rolling Section

of the Central Works Laboratory

"Zaporozhstal'" Works

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pp. 21-23, January, 1961

In connection with the rapid growth of the production of plastics and the manufacture of pressed plastic goods with a smooth surface, a great demand developed for large-size polished and ground stainless steel plates which are used in pressing equipment.

The production of ground plates at the "Zaporozhstal'" Works was started in June 1957 after two ShPM-1500 belt grinding machines (Fig. 1) were installed and put in operation. The production of plates involves the rolling of slabs into strips which are then wound into coils, hardened, the edges cut, and the strips pickled. After the cold rolling and subsequent thermal treatment, the strip is cut into sheets 1.5 x 1000 x 1500-2250 mm.

In the course of the manufacture of ground plates the effect of individual operational parameters on the quality of the surface of the finished plates was studied and some design defects were detected in the ShPM-1500 grinding machines.

Finishing of the plates and their quality. Experience on the production of ground plates indicates that the surface quality of the finished plate depends on the condition of the surface of the cold-rolled plates.

Before the grinding, the plates should be absolutely free from any visible surface defects since the removal of the defects involves grinding off a substantial layer of metal, which greatly increases the time of a grinding operation. In addition, during the removal of existing defects, new defects can appear (scratches, burns). Plates designated for grinding should be as even as possible (not more than 2 mm difference per 1 meter length).

During the initial period of operations the heat-treated and pickled plates from 1Kh18N9T, 1Kh18N9, and 2Kh18N9 steels were ground. With regard to the surface quality, the heat-treated plates did not satisfy the Works technical specifications for plates designated for grinding. The production method for heat-treated plates did not ensure a defectless surface (roughness, indentation, scratches).

In this connection, a study was carried out* with the object of improving the quality of the semi-finished plate. A batch of plates, 1.5 × 1000 × 2300 mm, was rolled from steel 1Kh18N9T. These plates were made by the usual methods for stainless steel (cold rolling, hardening, pickling). Another batch of plates was rolled and work-hardened with the use of polished rolls. The surface quality of the work-hardened plates was considerably better than that of the pickled ones.

It is very important that during the production of plates for grinding the equipment be clean and operating smoothly. Cold rolling and dressing must be carried out with thoroughly polished rolls.

Before the steel which is designated for the production of ground plates is processed, the dust and dirt on the equipment of the hardening and pickling trains as well as on the rolling and dressing mill and on the cutting train should be removed and the equipment should be washed with benzine. Any defective part should be repaired or replaced.

* M. M. Stekachev, L. A. Zagadchenko, and G. A. Drobot collaborated in this work.

Adhesive materials for the abrasive powder and the preparation of the abrasive belt. The plates are ground with the endless abrasive belt, which is made of grade "ChSh drying" technical cloth. High-grade hide glue is used as the binding material for the abrasive (normal electrocorundum) which is applied to the belt.

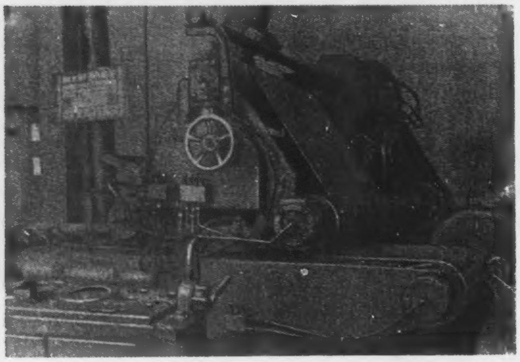

Fig. 1. ShPM-1500 grinding machine.

The use of water glass as the adhesive was not successful. In the course of the grinding operation, deep cracks used to appear on the surface of the belt (Fig. 2) and caused surface defects on the ground plate. The use of hide glue reduced the formation of cracks on the belt and improved the quality of the plate surface. A special piece of equipment was made for the application of the abrasive to the belt (Fig. 3). The equipment consists of a steel plate tank, with four rolls—two for stretching the belt and two for applying the abrasive and smoothing it out on the surface of the belt.

The hide glue and the abrasive are applied to the belt by hand with the use of a sprayer. After the application of abrasive, the belt is dried by electric heaters installed at the bottom of the tank.

The belts made in this way show less tendency to crack, have a long service life, and produce a better quality of ground surface. However, this method of applying abrasive to the belt does not ensure a uniform distribution of the adhesive material or of the abrasive powder on the belt surface since this operation depends entirely on the skill of the worker. It is essential to develop a mechanical method of applying the abrasive to the belt so that a uniform distribution over the whole surface of the belt can be obtained.

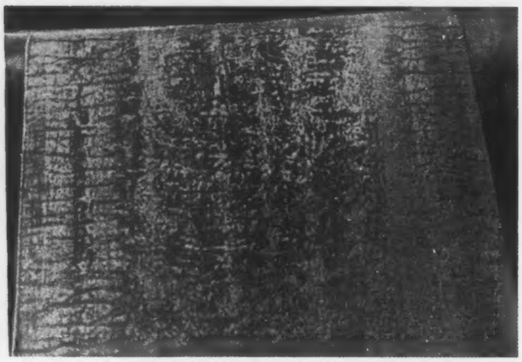

Fig. 2. Cracks on the surface of the abrasive belt.

The abrasive from used-up belts is removed by dissolving the adhesive in hot water. The cleaned belt is dried while being stretched. Experience shows that the best abrasive for the grinding is electrocorundum (aluminum oxide).

As a result of an improvement in the quality of the surface, the following optimum regime of grinding the sheets was accepted:

1) Rough grinding; 100 mesh abrasive used.

2) Pre-finishing grinding; 150 mesh abrasive used.

3) Finishing grinding; 180 mesh abrasive used.

The grinding with the abrasive of 100 mesh is carried out without a lubricant in order to obtain a better removal of defects from the surface of the sheet. The abrasives of 150 and 180 mesh are used in the form of a paste. When changing from one type of grinding to another the grinding belts are changed and the surface of the sheets is carefully wiped with a soft cloth wetted with benzine in order to remove any grease or abrasive.

This method of grinding ensures that the sheets fall into class 9-10 of finishing according to the GOST 2789-51 scale.

The grinding belt machine consists of delivery and grinding mechanisms. The delivery mechanism has an endless rubberized belt with holes through which the sheet to be ground is held tightly against the belt by means of a vacuum pump. The speed of the delivery belt is 3.2-11 m/min. The grinding mechanism consists of three

rolls, which are arranged on an equilateral triangular pitch and which carry an endless abrasive belt of 1 mm thickness and 1300 mm width. One of the two lower rolls drives and the upper roll can be adjusted vertically in order to regulate the tension of the belt. The speed of the abrasive belt does not exceed 10 m/sec.

To vary the direction of grinding, the grinding mechanism undergoes an oscillation movement relative to the vertical axis with a deviation of approximately 10-12° from the direction of grinding.

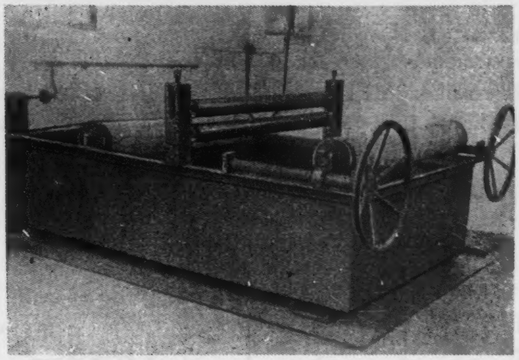

Fig. 3. Equipment for the application of abrasive powder to the grinding belt.

The belt is pressed against the sheet which is being ground by four steel rollers, 100 mm in diameter. The displacement of the tightening mechanism in the vertical direction is effected pneumatically and the air pressure is controlled by means of a special reducing valve.

On the basis of accumulated experience on the production of ground sheets from stainless steel, one can draw the following conclusions:

1. The quality of the finished plates depends first of all on the quality of the hot-rolled and cold-rolled plates. The plates designated for grinding should be absolutely free from surface defects since the removal of defects entails the removal of a substantial layer of metal and that results in a considerable increase in the time required for grinding and impairs the quality of the ground surface.

2. The existing method of applying the adhesive and the abrasive to the belt by means of a sprayer (by hand) does not ensure an absolutely uniform coverage of the belt with the abrasive over its whole length and width. It is essential to develop a mechanical method of applying the abrasive powder to the belts.

3. The rubberized conveyer belts do not satisfy the requirements of the production process because of the variation in the thickness (2-4 mm deviation in 12 mm thick belt), inadmissible stretching during the operation (up to 10%), cracking and splitting of the upper covering layer.

4. The endless abrasive belt made of felt exhibits excessive non-uniform stretching (up to 15%) which causes splits in the abrasive layer and renders the belt useless. Undesirable inclusions which occur in these belts cause scratches on the ground surface.

5. The ShPM-1500 belt grinding machines have a number of substantial defects and, therefore, they cannot be recommended for grinding large-size sheets. Design organizations should develop a new design of grinding machine, taking into account recent advances at home and abroad and providing facilities for grinding both sides of a strip or of separate sheets.

6. For mass production of ground and polished sheets and strips it is desirable to set up specialized production lines which would include the cold-rolling of material to be ground.

AN AUTOMATIC GAGE FOR MEASURING THE WIDTH OF ROLLED PRODUCTS

É. Yu. Gutnikov and N. N. Chuzo

Uralmetallurgavtomatika
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For measuring the length of moving sheets or rolled sections during the rolling process, the Uralmetallurgavtomatika developed a contactless discrete photoelectric gage, type LÉM-59, which is actuated by the radiation from the hot metal.

Lead sulfide photoresistances, type FS-A1, are used as photo-sensors. They are highly sensitive to the infrared part of the radiation spectrum and, therefore, it is possible to measure the temperature at the end of the rolling operation.

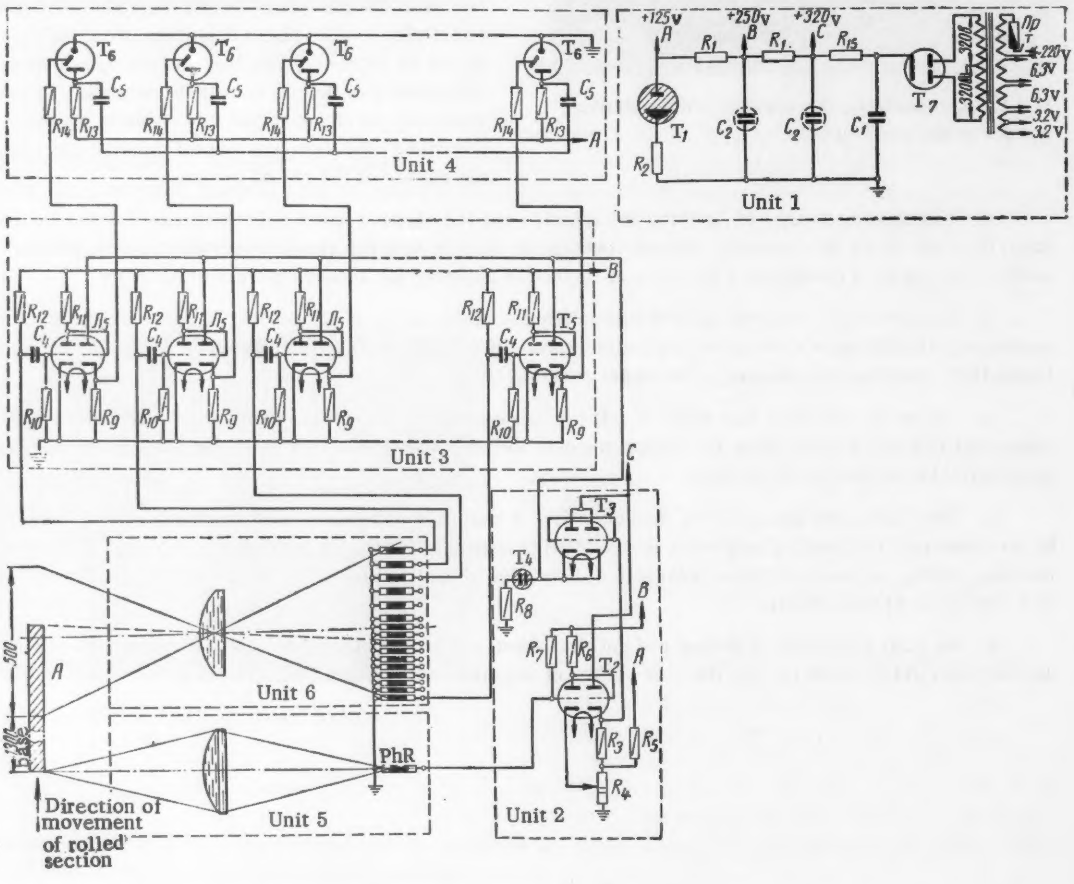

Fig. 1. Schematic circuit of the automatic gage.

The LÉM-59 automatic gage measures the variable part of the length of the stock within the range of 500 mm, and the constant length (the base) can be of practically any magnitude.

Fig. 1 shows the schematic circuit of the gage.

When it leaves the roll the front edge of rolled piece A comes within the limited field of vision of the base photoresistance (unit 5), which is inserted at the entry terminus of the base electronic dc amplifier (block 2) with relay characteristics.

The lighted base photoresistance lowers its internal resistance and hence reduces the positive potential on the grid of the left triode of the tube T_2. The amplified potential from R_6 is transmitted to the grid of the right triode, which operates in the regime of the cathode follower. A further link with the power stage is effected directly.

The power stage at tube T_3 operates as a voltage key ("Yes", "No"). The voltage is transmitted to the cathode followers of the pulse stages at the moment when the base photoresistance lights up, thus preparing the system for taking a measurement. The use of the cathode followers in the gage circuit ensures that the system can operate when the supply voltage or the parameters of the tubes are changed. A neon lamp T_4 serves for the visual control of the position of the sensitivity regulator R_4.

The rolled piece in the field of vision of the base head moves forward and enters the field of vision of the position head with linear photoresistances (unit 6) and lights them up in turn as it moves forward and sends negative pulses to the corresponding pulse stages.

The pulses received are amplified, changed in sign and transmitted from the cathode followers through the resistances R_{14} to the trigger anodes of the thyratrons with a MTKh-90 cold cathode. The thyratrons can be in one of two stable positions. If the thyratrons receive voltage U_b, which is higher than the extinction potential but smaller than the firing potential U_f ($U_e < U_b < U_f$), then the thyratron can be either in the extinguished or in the fired stage.

The lighting of the gas indicates which of the two possible states the thyratron is in. The fired thyratron indicates the measured length of the rolled piece on the calibrated scale. Only one thyratron can be in a fired state since, quite independently from the lighting up sequence of the thyratron, the fired thyratron sends a negative pulse to all the anodes through the common capacity circuit C_5 which links the thyratrons. An original scheme of extinguishing the cold-cathode thyratrons is employed in the LÉM-59 gage. This scheme makes it possible to sum all the received pulses in multi-channel circuits.

The change of readings takes place at the time when the measuring cycle of the next rolled piece is started.

One should mention the difficulties in the use of photoelectronic instruments for measuring hot steel when the mill rolls are cooled with water and the scale is hydraulically removed. The use of water results in a large quantity of steam appearing on the tail end of the rolling stand. Hence, there is a substantial increase in the vision angle of the base head as a result of the multiple reflections of the radiation, which fluctuates, depending on the intensity of steam at the moment of the measurement, and causes significant errors in the measurements. If, however, the base head is installed further away from the zone where the steam is formed and at a greater distance from the rolls, the working cycle during the reversible rolling is extended and this then reduces the output.

To eliminate the effect of steam on the measurement and to reduce the time required for measurements, some plants, where water cooling is employed, applied the following method of installing the base head (Fig. 2).

The base head (unit 5), which determines the beginning and the end of the rolled piece, was installed not at the tail end but at the front end of the stand. It was positioned in such a way that the recording of the disappearance of the tail end of the rolled piece took place instantaneously, independently of the presence of the steam, as soon as the rolled piece disappeared between the rolls. In this method, the fluctuation in the elongation of the still non-rolled part in front of the stand and between the rolls is not taken into account. The length of this part may amount to 50-70 mm. Taking this length and any possible elongation into account, the additional error can be 0.5%, which is within the basic (1-1.5%) error of the instrument. The method described can be employed for measuring the length of the rolled product to an accuracy of ± 10 mm.

Changes in the temperature of the rolled piece, within the limits of 500-1000° C, and changes in the speed, within 0.5-5.0 m/sec, do not affect the accuracy of the measurement.

The weight of the instrument is 43 kg, including the measuring heads; the size of the electronic unit is 185 x 490 x 345 mm; the size of the heads is 245 x 155 x 250 mm.

Similar instruments for measuring the length of rolled products have been described recently in literature from abroad. Thus, for instance, a new instrument which automatically measures the length of steel sheets moving on a conveyer was described in an American journal in 1958.* The principle of measurement is practically the same as the one described above.

The instrument described has been used experimentally on a commercial scale for a long time at the Seversk and Nytvinsk Metallurgical Works and has shown good results during continuous 24-hour operation. The automatic measurement of rolled steel, especially at plate rolling mills with reversible rolling operations, makes the work of the operator easier, reduces defective production and scrap substantially, and increases the output of the mill.

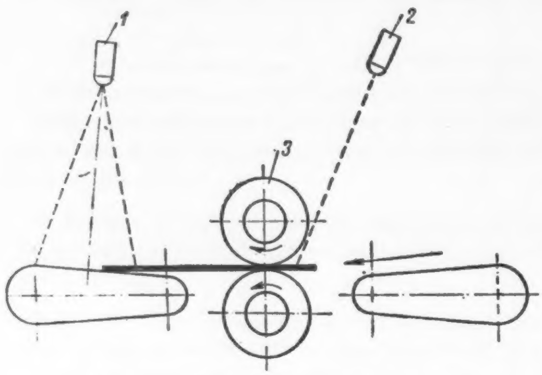

Fig. 2. Arrangement of the base head of the automatic length gage: 1) Unit 6; 2) unit 5; 3) mill rolls.

LUBRICATION IN TUBE ROLLING

V. Ya. Osadchii and R. M. Golubchik

Moscow Steel Institute

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As a result of forces caused by the conical shape of the rolls and the mandrel and as a result of the supporting friction forces acting on the steel by the working tool during the rotary rolling of the tube, there is some sliding of the steel relative to the surface of the rolls. To reduce the supporting friction forces in the axial direction, it is necessary to minimize the friction coefficient on the internal tube surface, that is, at the boundary of the steel and the mandrel, and this can be done by the application of a lubricant.

In the selection of the lubricant and of the method of applying it to the working surface of the working tool or to the internal surface of the tube, one should take into account the practical capabilities of industrial machines.

The effect of various technological lubricants on the output was studied† on the rotary rolling mill of the "220" and "140" Nos. 1 and 2 tube rolling units of the Pervouralsk Tube Works. In the experiments, the rolling was carried out: a) without a lubricant; b) with salt thrown into the receiving trough of the rotary mill; c) with salt thrown into the tube downstream of the automatic stand; d) with air scale; e) with furnace scale; f) with a mixture of furnace scale and salt (1:1).

* The Iron and Steel Engineer, 1959, No. 1, page 137.

† A. Z. Gleiberg, P. E. Nenashev, É. O. Nodev, L. S. Rakhnovetskii, A. V. Rabinzon, and V. F. Pikalov collaborated in this work.

The scale was screened beforehand on a 1-mm screen. At the moment when the tube was placed on the delivery roller tables of the rotary rolling mill, i.e., 5-8 seconds prior to the rotary rolling, the lubricant (80-100 g) was introduced by means of a special trowel. The tube was covered as far inside as possible (0.8-1.0 mm) with a uniform layer starting from the front end.

For the elimination of the effect of the length of the billet and hence the length of the tube, measurements were taken not of the total rotary-rolling time but only of the time of the passage of the front end of the tube up to a certain distance between the guides of the delivery table.

Simultaneously with the speed measurements, the pressure of the steel against the rolls at the rotary rolling mills of the 220 and 140 No. 1 units was determined. The results of the measurements showed that the pressure of the steel against the rolls did not change significantly whether the tubes were rolled without or with various technological lubricants.

The rotary rolling of tubes at the 220 unit is usually carried out without any lubricant but sometimes, during the rolling of thin-wall tubes, the operator throws some kitchen salt (100-150 g) into the entry channel of the sizing mill. When entering the channel the tube rakes out the salt, as it were, and only part of the salt enters the tube. This method of applying the lubricant is not the most economical one, though it has a definite effect since the mill-operation time is reduced by 9.2%.

All other lubricants have less effect. This is explained by the lower temperature of rotary rolling (800-850° C), which ensures softening and melting of the kitchen salt (its melting point is 820° C), but is not high enough to soften the scale.

However, when 174 x 34 mm tubes are rolled at a high temperature, furnace scale is more effective than salt. This is explained by an extensive melting of the salt and the loss of its absorptive properties, which are necessary for reducing the friction coefficient. The scale, on the other hand, softens at a high temperature (1000-1050° C) and acts effectively as a lubricant.

Although, as a rule, the rolling of thick-wall tubes (174 x 34 mm) on the rotary mills proceeds smoothly, nevertheless the use of lubricants is fully justified (the consumption of electric power and the wear of the rolls and mandrels are reduced).

The use of technological lubricants during rotary rolling of 83 x 5.75 mm tubes made from 1Kh18N9T steel at the 140 No. 1 unit has a relatively small effect. The rolling time is reduced by 5% and this figure is practically the same for all lubricants. This phenomenon can be explained, apparently, by the fact that owing to its specific physical and mechanical properties the dense air scale which forms on the tube after the tube comes from the automatic mill neutralizes the effect of the technological lubricant and has the same effect on the rolling. However, the effect of the lubricant on the length of the reeling time becomes more marked during the production of 83 x 4 and 83 x 3.25 mm tubes from steel 20 (the operating time is reduced, on the average, by 15%). This makes it possible to increase the throughput of rotary mills of the unit.

The 140 No. 2 machine is used mainly for rolling thin-wall tubes. Therefore, the temperature of the tubes is relatively low (approximately 800° C). To make the rotary rolling process easier, the operator throws 30-50 g of salt into the tube when it passes by with a small trowel. During the rolling of 83 x 3.6 mm tubes from steel 10 the application of salt downstream of the automatic mill has the best effect. The throwing of salt by the operator in the way it is done now cannot be considered rational. In a short period of time, a relatively small quantity of salt does not soften in a comparatively cold tube and does not act as a lubricant.

On the basis of the investigations carried out, the following conclusions can be drawn: a) the introduction of the technological lubricant inside the tube prior to the rotary rolling reduces the rolling time and hence increases the output of the rotary rolling mill; b) when technological lubricants are used, the stresses during the rotary rolling do not, as a rule, increase and consequently the power consumption does not increase; c) to apply the lubricant correctly, it is necessary to install an automatic lubricant feeder which would apply the lubricant over a substantial length of the rolled tube.

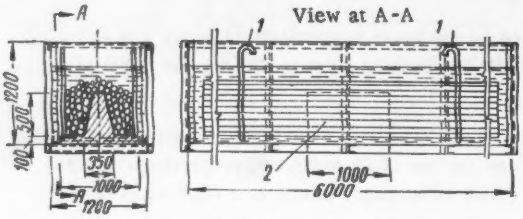
PICKLING BARS WITHOUT THE USE OF INSERTS

V. F. Isupov, Head of the Central Works Laboratory at the A. K. Serov

Metallurgical Combine

Translated from Metallurg, No. 1,
p.27, January, 1961

A new method of pickling steel bars without the use of inserts has been developed and applied at the Serov Combine finishing shop. A bundle of bars without inserts is charged into a pickling bath and kept there for about two-thirds of the time specified by operating instructions; it is then transferred to a washing tank filled with water, having a wedge-shaped support at its bottom (see figure). When the bundle is lowered into the tank the bars in its center and lower portion are displaced upwards. The slime in the bundle's center and in places of contact between the rods is totally removed. The bundle is then returned to the pickling bath, where the final removal of scale from the bar surfaces takes place. The bundle is then washed again with water in the tank with the wedge-shaped support. Subsequent processing (neutralization and sulling) is carried out in the normal manner.



Tank with wedge-shaped support: 1) Bar bundle suspended on hooks; 2) support.

Bars pickled in this way have a clean surface without any trace of scale, while in ordinary pickling with the use of inserts some scale often remains in the places where the rods touch.

Pickling without inserts made it possible to improve the quality of the metal surface, increase output, reduce consumption of acid by 7%, and increase the service life of the pickling tanks.

IMPROVEMENTS IN THE EQUIPMENT OF ROLLING SHOPS

V. P. Emel'yanov

Magnitogorsk Metallurgical Combine

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pp. 28-30, January, 1961

Reducing the Wall Thickness of Heat-Treating Furnaces

According to the original design data, the wall thickness of the heat-treating furnaces at the Plate Rolling Shop of the Magnitogorsk Metallurgical Combine is 803 mm ($3\frac{1}{2}$ standard bricks). Because of the heavy load and the high rate of operation of the furnace, the walls wear rapidly. Repairs to the walls consume a large quantity of refractory materials. In addition, the existing number of furnaces is not sufficient to cater to the increased production of steel plate.

On the suggestion of N. M. Shemetov and V. A. Zakharov, the walls at some of the heat-treating furnaces have now been made 573 mm thick ($2\frac{1}{2}$ bricks). In this way it has become possible to increase the working volume of the furnaces and to reduce the consumption of refractory materials and other repair materials.

As a result of increasing the volume of the furnaces, the back pressure in the fire boxes has been decreased and consequently it is possible to make better use of the firing capacity of the burners, to increase the service life of the furnace arches and grid screens, and to reduce the local overheating of steel.

One year's experience on the operation of furnaces with thin walls showed that their durability is satisfactory. The heat losses, however, increased. To reduce heat losses, an asbestos interlay, approximately 5 mm thick, has been placed between the brickwork and the steel shell of the furnace.

Some investigations were carried out on the thin-wall furnaces and corresponding measurements were taken in order to evaluate the operational characteristics of the furnaces.

The investigations showed that the heat losses from thin-wall furnaces due to thermal conductivity constitute 4.6% as compared with 3.3% losses from thick-wall furnaces. This increase in heat losses is, however, fully justified in view of substantial savings in refractory materials and repair equipment. Four furnaces alone provided savings of approximately 150,000 rubles per annum as a result of this modification.

Extending the Service Life of Electric Vacuum Furnaces

At the cold-rolling shop, steel sheets for transformers are annealled in UKR03B electric vacuum furnaces equipped with heating coils made of Kh20N80T3 chromium-nickel-titanium refractory strip.

Because of some technical defects, the heating coils of the electric vacuum furnaces burn through frequently and cause furnace stoppages and steel waste. The burning is caused by the short-circuiting of the coils through the fire bricks because their surface becomes saturated with carbon from the non-degreased metal in the course of the operation and loses its dielectric properties. This is the result of an unfortunate connection system for the heating coils. Because the potential difference between adjoining coils is up to 380 volts and the space separating the coils has low dielectric properties, short-circuiting occurs frequently.

The dielectric properties of the space between the coils are reduced because of the intensive evaporation of the sodium from the protective layer on the muffles, which consists of water glass containing 25% Na_2O.

On the suggestion of S. V. Murinets, G. M. Zhuravel', and V. P. Beshentsev, the following steps, aimed at the elimination of the burning-through of the heating coils of the electric vacuum furnaces at the Magnitogorsk Metallurgical Combine, have been taken:

1. The space between the coils is kept clean.

2. The circuit diagram of the heating coils has been modified in such a way that adjoining coils in the places of the lowest dielectric strength are at the same potential.

3. The use of water glass for covering the muffles has been discontinued.

All these measures have made it possible to eliminate the burning of heating coils and almost doubled the service life of the coils.

Increasing Output of Reheating Furnaces

The upper heating zones of reheating furnaces for heating slabs before plate rolling on the thin-plate mill usually have six burners for fuel oil firing (fuel consumption is 240 kg/hr). In the course of operation the burners frequently used to become clogged up and, therefore, the heating regime of the slabs was upset and the output of the mill was reduced. In addition, the clogging up of the burners made the work of the operating personnel very difficult since the burners had to be cleaned frequently.

On the suggestion of I. S. Suslov, two burners (instead of six), burning 500 kg/hr of oil each, have been installed in the upper heating zone of the reheating furnaces at the thin-plate mill. The bigger burners do not clog up and ensure a normal heating of the steel. In addition, the new burners produce a spread flame, and not an elongated one as used to be the case with the old burners, and thus contribute to an extended service life of the longitudinal walls of the furnace.

The adoption of this suggestion has reduced the fuel consumption and increased the output of the mill, resulting in over 100,000 rubles savings per annum.

Modifications in the Design of Guide Bars and Guides on Rolling Mill Stands

For the entry and delivery of the slabs to and from the rolls at the two-high medium-thick plate mill there are cast guides attached to cross-bars, eight guides for each bar (Fig.1). In the course of operation, the joint be-

tween the guides and the bar wears, becomes weaker, and the guides become detached from the bar, causing stoppages of the mill. When the outside and especially the bottom part of the guide becomes worn, they have to be replaced.

With the object of reducing the stoppages of the mill caused by the wear of the guides, B. M. Sinitskii and I. A. Chuprina suggested that the design of the guide bar and guides at the medium-thick plate shop of the Magnitogorsk Metallurgical Combine should be modified by combining them into one single cast unit. The new guides are cast from steel and require very little machining (Fig. 2).

On the working surface of the guides there are recesses to facilitate the removal of the scale from the hot billets. The new guide is fixed in specially designed seats on the frame of the rolling tables (Fig. 3). The machined ends of the guide enter inverted-channel sections, screwed to the frame. Spherical supports and interlays are placed under the supporting parts of the guide. A wedge which is inserted between the inverted-channel section and the tail end of the guide is used to improve the rigidity of the joint.

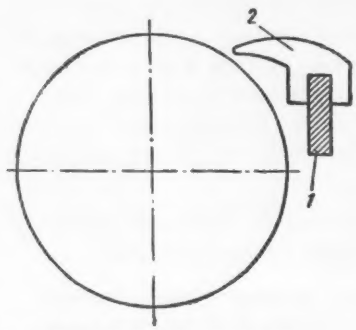

Fig. 1. Old design for guides and cross-bar: 1) Cross-bar; 2) guide.

The new guides serve 20-25 times as long as the old ones. Only the external part of the guide is worn, that is, the surface, which is eroded by the billets rolled and which can be built up with metal at regular intervals.

With the introduction of this suggestion, the manufacture of the guide for a single two-high stand saved approximately 5000 rubles per year.

Combining Control Points of Reheating Furnaces

The entry of the slabs into the reheating furnace and their delivery from the furnace to the rolling tables are effected by a pusher controlled by an operator. Three reheating furnaces at the medium-plate shop of the Magnitogorsk Metallurgical Combine were controlled by two operators from control points Nos. 2 and 3.

The delivery of the slabs to the rolling tables was frequently irregular because of the lack of co-ordination between the operators, caused by poor visibility of the equipment at the furnaces and the adjoining sections. In addition, the operators were not always fully occupied.

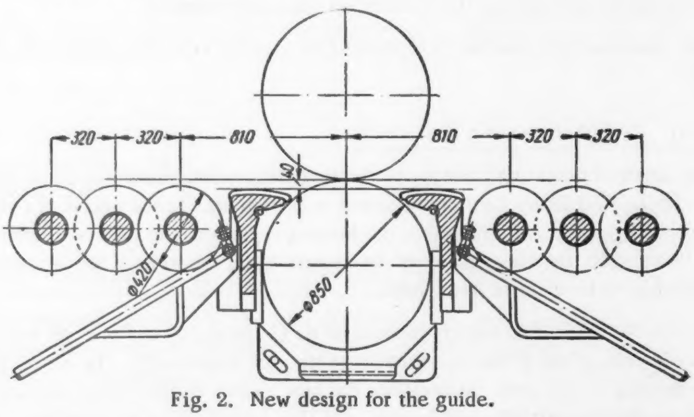

Fig. 2. New design for the guide.

The work study engineers at the medium-plate shop of the Magnitogorsk Metallurgical Combine, F. I. Goncharov, P. E. Demin, and F. M. Chikunov, suggested that control points Nos. 2 and 3 should be combined into one control point for the furnace pushers.

Now, all the equipment controlled by the operator is within his field of vision because the control point has been placed slightly above the equipment.

Bulky and cumbersome controllers have been replaced by universal switches mounted on a control panel. By combining two control points into one, normal operation of the mill has been ensured and a saving of approximately 50,000 rubles per annum has been achieved.

On the suggestion of the same work study engineers, control points Nos. 1 and 2 at the medium-plate mill of the plate straightening and sorting sections have been combined into one control point placed on an elevated platform on the right-hand side of the train. Previously, the operation of the train was effected by two operators from two control points. The operator at control point No. 1 controlled the operation of the approach rolling tables and the straightening machine, and the operator at control point No. 2 controlled the operation of the intermediate rolling tables, the shears, the marking machine, and the delivery rolling tables.

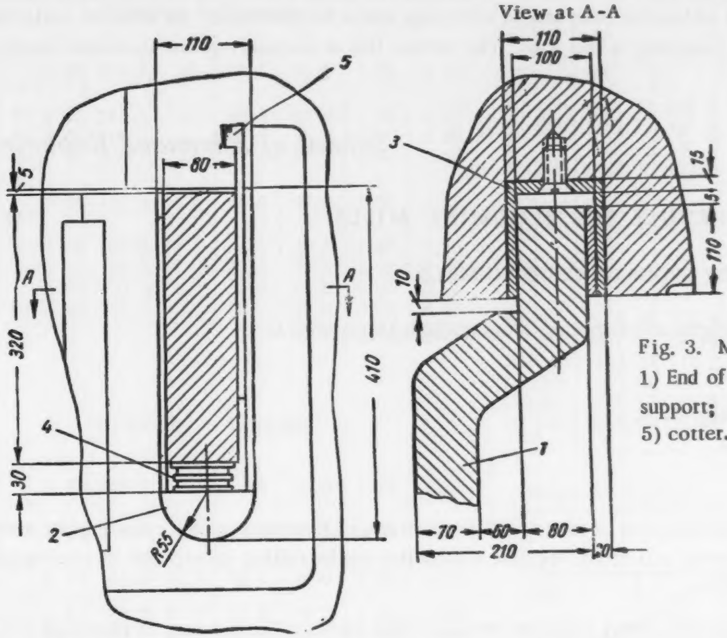

Fig. 3. Method of mounting the guide: 1) End of the guide; 2) hemispherical support; 3) П-shaped section; 4) inserts; 5) cotter.

Since the control point is located on the right of the train on an elevated platform, the whole train can be supervised and a normal operation of the unit can be ensured. The combining of the two control points resulted in a saving of 45,000 rubles per annum.

Modified Bearings for the Rollers of the Elongation Roller Table

At the medium-plate mill, the bearings of the rollers of the elongation roller tables, located behind the stand in the vicinity of the hydraulic removal of scale, used to break down frequently because of the ingress of water and scale. This caused stoppages of the mill and necessitated frequent repairs of the bearings. The bearings

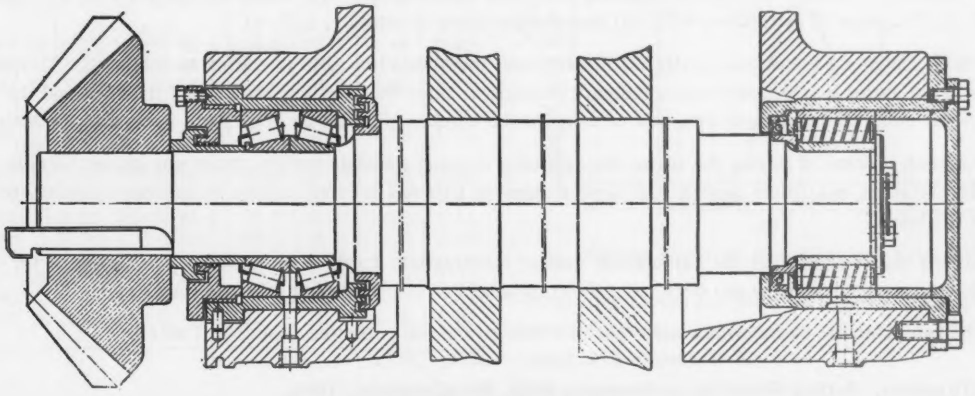

Fig. 4. Roller of the elongation roller table.

were mounted directly in the frame and were covered with lids; the flanges on the frame and on the lids protected the bearings from the ingress of water. Because of the lack of a seal, scale could enter the bearings.

To prevent the bearings from being contaminated with scale and to increase their service life, L. Yu. Lada suggested that the bearings of the rollers at the medium-plate shop of the Magnitogorsk Metallurgical Combine should be modified (Fig. 4). The bearings have been mounted in bearing boxes, sealed on the driving side with lids and a labyrinth seal. On the nondriving side, the flanges on the frame and on the lid have been machined off, and the bearing with spiral rollers has been sealed with rings and a Sevonite seal. No water or scale can enter the bearings now that they are protected in this way. The service life of the bearings has increased threefold.

School of Advanced Experiments

OPTIMUM ROLLING-SCHEDULE FOR BLOOMING MILLS

REPORT TO INTERPLANT STUDY GROUP ON COGGING MILLS

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At present two methods are recorded of raising the productivity of blooming mills: reducing the number of passes, which, if the motor power is limited, requires a reduction in the rolling speed; and increasing rolling speed with moderate reductions.

At home and in foreign practice many cases are recorded of a considerable increase in blooming mill productivity by reducing the number of passes. Generally, this has been practiced with inadequate drafts.

Numerous recommendations have been made for further reducing the number of passes and bringing the average drafts in existing blooming mills up to 100-150 mm. In doing so, to achieve the gripping of the metal by the rolls, it has been proposed that the metal should be forcibly advanced, that the rolls should be fluted, and so on.

The desirability of a particular method of raising a blooming mill's productivity can be determined by comparing the calculated optimum rolling schedule of several different methods permissible for the given plant.

Let us, for example, carry out the calculation of the optimum schedule for rolling rimming steel ingots [(770 x 600)/(810 x 640)] x 2200 mm, weighing 7.05 tons, into blooms 345 x 315 mm in 9, 11, 13, or 15 passes, using V. A. Tyagunov's* method (we will call them respectively schemes 1, 2, 3, 4).

These schemes exhaust practically all the different methods admissible in rolling such blooms. To roll them in seven passes is impossible under ordinary conditions, since the gripping capacity of the rolls and the power of the motor do not permit this, and to increase the number of passes to 17 or more is clearly not desirable.

For each scheme of rolling the ingots the optimum working schedule for the motor was chosen (acceleration, deceleration, maximum speed); the same number of tilts was adopted, except in scheme 1, where there was one tilt less.

All the initial figures for the calculation (rolling temperature, moment of gyration, parameters of the screw-down equipment, and so on) were taken from figures of actual blooming mill working.

The results of the calculation are set out in Table 1, and the collected figures in Table 2.

* V. A. Tyagunov, Rolling Schedules on Reversing Mills, Metallurgizdat, 1954.

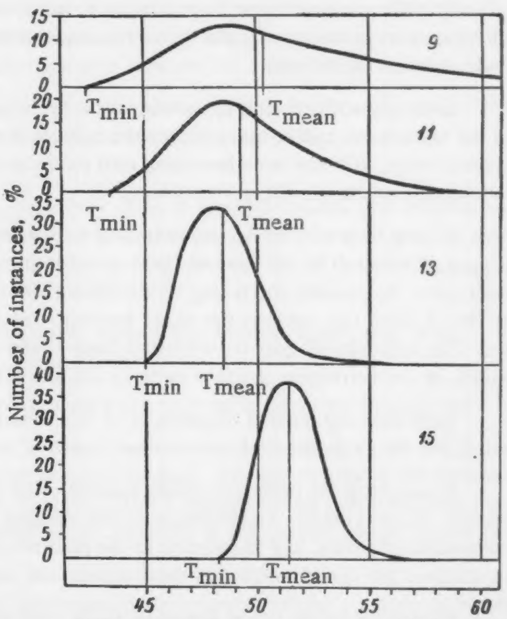
TABLE 1. Calculation of Optimum Rolling Schedules

Pass number	h, mm	Δh, mm	L, m	M_{max}, tons · m	n_{grip}, rev/min	n_{max}, rev/min	n_{eject}, rev/min	t_{pause}, sec	t_{mach}, sec
a) Rolling in 9 passes									
1	670	100/140	2.20	211.7	0	41.4	41.4	1.95	2.10
2	575	95	2.35	213.6	0	42.4	42.4	1.95	2.17
3	480	95	2.76	224.7	0	45.0	45.0	1.90	2.36
4κ	390	90	3.32	225.7	0	47.7	47.7	3.80	2.55
5	565	90/130	3.88	151.3	15.0	51.9	47.5	1.90	2.21
6	475	90	4.46	160.0	14.2	54.1	47.5	1.90	2.46
7	385	90	5.33	168.7	14.2	57.4	47.5	1.90	2.78
8κ	295	90	6.77	176.1	14.2	60.0	60.0	3.20	3.26
9	345	105	8.25	156.4	0	60.0	60.0	3.73	4.28
								22.23	24.17
b) Rolling in 11 passes									
1	690	80/120	2.20	209.9	0	47.2	43.9	1.79	1.48
2κ	610	80	2.25	216.9	0	48.6	48.6	3.80	1.50
3	560	55/95	2.59	131.0	40.0	50.0	38.0	1.55	1.15
4	500	60	2.83	188.9	31.5	50.0	36.3	1.48	1.29
5	445	55	3.12	185.2	30.1	50.0	36.3	1.48	1.38
6κ	390	55	3.47	191.3	30.1	50.0	50.0	3.50	1.47
7	570	95	3.85	195.2	10.0	50.0	48.8	1.95	1.99
8	475	95	4.45	203.5	10.0	50.0	47.5	1.90	2.23
9	385	90	5.40	202.6	15.0	61.4	47.5	1.90	2.40
10κ	295	90	6.87	209.4	15.0	65.0	65.0	3.20	2.84
11	345	100	8.25	184.1	5.0	65.0	65.0	3.89	3.37
								26.44	21.10
c) Rolling in 13 passes									
1	715	55/95	2.20	105.6	50.0	50.0	36.3	1.48	0.91
2	660	55	2.20	133.7	45.4	50.0	36.3	1.48	0.92
3	605	55	2.27	138.0	45.4	50.0	36.3	1.48	0.95
4κ	550	55	2.46	142.4	45.4	50.0	50.0	3.80	1.00
5	565	60/100	2.85	113.5	50.0	50.0	38.0	1.55	1.16
6	505	60	3.10	143.6	46.1	50.0	38.0	1.55	1.27
7	445	60	3.42	149.3	46.1	50.0	36.3	1.48	1.41
8κ	390	55	3.81	145.5	45.4	50.0	50.0	3.50	1.54
9	530	75	4.19	132.7	50.0	69.2	44.8	1.79	1.45
10	450	80	4.81	144.0	48.6	70.0	44.8	1.79	1.66
11	370	80	5.73	149.5	48.6	70.0	43.3	1.73	1.75
12κ	295	75	7.04	147.8	47.9	70.0	65.0	3.20	2.25
13	345	90	8.25	200.4	15.0	75.0	75.0	4.09	2.87
								28.92	19.14

TABLE 1 (continued)

Pass number	h, mm	Δh, mm	L, m	M_{max}, tons · m	n_{grip}, rev/min	n_{max}, rev/min	n_{eject}, rev/min	t_{pause}, sec	t_{mach}, sec
d) Rolling in 15 passes									
1	720	59/90	2.20	122.7	50.0	59.4	34.6	1.41	0.85
2	670	50	2.20	124.5	47.5	57.6	34.6	1.41	0.87
3	620	50	2.25	127.5	47.5	58.0	34.6	1.41	0.89
4	570	50	2.43	130.4	47.5	58.7	32.9	1.34	0.96
5	525	45	2.62	123.8	46.6	59.1	32.9	1.34	1.04
6	480	45	2.82	127.1	46.6	60.0	32.9	1.34	1.10
7	435	45	3.06	130.5	46.6	61.2	32.9	1.34	1.19
8κ	390	45	3.37	134.2	46.6	66.4	60.0	3.80	1.18
9	585	60/100	3.85	110.3	50.0	67.8	38.7	1.55	1.38
10	525	60	4.18	113.9	49.0	68.6	38.7	1.55	1.49
11	465	60	4.66	116.4	49.0	70.7	38.7	1.55	1.61
12κ	405	60	5.30	119.2	49.0	75.0	60.0	3.50	1.72
13	355	65	6.12	127.0	50.0	75.0	38.7	1.55	2.00
14κ	295	60	7.20	123.5	49.0	75.0	65.0	3.20	2.22
15	345	80	8.25	203.1	25.0	80.0	80.0	4.13	2.71
								30.42	21.21

Note: k = tilting



Rolling cycle for one ingot, sec (without pause)

Frequency curves for the time taken in rolling ingots in different numbers of passes (9, 11, 13, 15 – number of passes)

TABLE 2. Calculation of Optimum Rolling Schedules. Collected Figures

Number of passes	Average draft per pass, mm	Average rolling speed, m/sec	Motor acceleration, rev/min/sec	Machine rolling time, sec	Duration of pauses, sec	Total duration of cycle, sec	Mean-square motor moment, ton · m	Duration of cycle as conditioned by motor heating, sec
9	102.8	1.63	20	24.17	22.23	46.40	135.3	84.97
11	85.0	2.14	45	21.10	26.44	47.54	113.9	61.68
13	72.0	2.73	65	19.14	28.92	48.06	101.8	49.84
15	60.3	2.95	75	21.21	30.42	51.63	101.2	52.91

From the tables given, the following conclusions can be made:

1) The average rolling speed increases with an increase in the number of passes. This results from the increase in the rate of gripping, in acceleration, and in the maximum motor speed. A larger number of passes even with an unchanged motor scheme automatically increases the rolling speed because of the higher gripping speed.

2) The duration of the pauses increases with increasing number of passes. Machine time is a minimum in rolling with scheme 3. Both increasing and decreasing the number of passes increase machine time.

3) With a large difference in the schedule of drafts, the rolling cycle duration changes very much less. In reducing the number of passes from 15 to 9, that is, by 40%, the drafts increase by 70%, while the duration of the cycle is shortened in all only by 10%.

4) In working with large drafts, the rhythm is broken. For example, in 8-10 passes of scheme 3, the gripping rate for standard drafts and for the rolling diameter is less than that which the motor can develop during the pause. Therefore, in reversing the rolls, a false holding period is necessary. In passes 1-4 of scheme 1, while the length of the rolled product is still small, the maximum speed (it also is ejection speed) is less than that permitted by the working of the roll-conveyer.

5) Rolling with scheme 3 corresponds to the optimum schedule. With this scheme the shortest cycle duration (49.84 sec) is obtained under the motor heating conditions; this practically coincides with the smallest possible cycle duration (48.06 sec).

In rolling with scheme 2, the minimum cycle duration in all is 1.1% less than with scheme 3 (47.54 sec); on the other hand, taking into account the heating of the motor, the cycle duration is 23.8% higher (61.68 sec). Consequently, with the same blooming mill productivity, the motor working conditions as regards heating will be considerably worse in rolling with scheme 2.

Rolling with scheme 1 is possible only with a small number of ingots and, if the metal is successfully gripped, may result in the shortest cycle duration in comparison with the other schemes. However, even in the ideal case, the possible shortening of the rolling duration in comparison with scheme 3 will only be in all 1.66 sec (3.5%). Taking into account the motor heating conditions, this scheme is not entirely suitable for large-scale use. The difficulty of gripping with such large drafts also does not allow the calculated productivity to be obtained, in the derivation of which entirely reliable gripping was assumed.

Increasing the number of passes to 15 is undesirable, since by this one increases the minimum cycle duration and the cycle duration with account taken of motor heating.

In selecting the optimum rolling schedule, the working conditions of the equipment must be carefully studied. In carrying out a calculation on the strength of blooming mill details and units with the aim of reducing the number of passes, and in pointing to the presence of large strength margins in them, many investigators do not analyze the actual working of these details and units.

Experience in the use of blooming mills working with more severe drafts shows that details with adequate computed strength also frequently go out of service. There have been cases when the boosting of draft schedules has not been supported by basic calculations. The rolling schedules laid down have often been broken by operatives, and actual draft values have reached up to 120-150 mm or more with considerable widening of the products being rolled (which is sometimes suggested at present). Such a boosting of drafts leads to this: the duration of passes was not reduced, but on the contrary, was increased because of slips and the reduction in rolling speeds; the length of pauses was also increased.

The main and coupling shafts, the teeth of pinion shafts of blooming mills, etc., went out of service. In the breakdown of the teeth of pinion shafts, fatigue cracks from 8 to 30 mm deep were found in the fractures. In the roots of the majority of the remaining teeth, cracks had appeared from both sides of the tooth. Evidently, the accidents took place as a result of systematic overloading.

From the calculation carried out, it follows that the teeth of pinion shafts, in working with the rolling schemes under consideration, cannot be broken as a result of a single overloading, because the fracture turning moment cannot be created in actual rolling conditions in the blooming mill. However, with time breakdown of the teeth is unavoidable because of metal fatigue.

Starting from the number and size of the loading cycles, a tentative calculation was carried out for the life of pinion shafts under various rolling schedules. In reducing the number of passes from 13 to 11, the service life of pinion shafts is reduced by a factor of 1.53, and, in going from 11 to 9 passes, by a factor of 3.03.

The transmission of still greater turning moments,in instances when the motor is cut off by the protection device, very slightly shortens the total service duration of the shafts,but in small amounts, and does not appear to be a cause of failure.

The changeover to rolling with more intense drafts considerably reduces the service life of pinion shafts and can lead to their breakdown. This also applies to other overloaded details of the working line. All this must be taken into account in choosing a schedule of drafts, and if the same productivity can be achieved with a less intense schedule of drafts, then just this schedule should be preferred.

As a result of changing over to the optimum rolling schedule following scheme 3, the working conditions of the mechanical and electrical equipment were improved; the number of instances of automatic gear and preliminary safety devices cutting out was reduced, as were also accidents and loss time and the amount of slip. The hourly production capacity of the blooming mill was thus not reduced, and the yearly figure even somewhat increased.

The minimum cycle duration in rolling with scheme 2 is less than with scheme 3. However, the time taken in rolling individual ingots is, on the contrary, greater because of the difficulty in gripping, because of slip and the motor cutting off. Therefore, the average rolling duration with scheme 3 is somewhat the smaller.

In the figure, frequency curves are shown for the duration of rolling with different numbers of passes. The curves for rolling in 11 and 13 passes are constructed on the basis of numerous stop-watch data; for 9 and 15 passes the curves are hypothetical.

The figures of minimum possible cycle durations T_{min} are very close to those calculated and increase with an increase in the number of passes. Because of the fact that the difference between the minimum and the mean cycle duration increases with the intensity of the schedule of drafts, the smallest mean cycle duration T_{mean} occurs in rolling in 13 passes.

It is desirable to work just with the optimum drafts and not to strive for an excessive reduction in the number of passes or to increase the speed of rolling with the smaller reductions.

The rolling schedule should be determined for each plant separately, depending on its parameters and actual conditions.

If conditions are changed, the optimum schedule should also be changed. Whereas at present the optimum rolling schedule on the blooming mill at MMK is rolling in 13 passes, after a reconstruction that is planned (increasing the roll diameter, increasing the motor power, strengthening mechanical equipment, and so on) the optimum schedule will be rolling in 11 or even 9 passes.

There exist at present adequately reliable methods of determining the optimum rolling schedule in blooming mills. Despite a certain crudity in the calculations, the results merit the work being carried out on all the country's blooming mills.

THE OPERATION OF LARGE CAPACITY BLAST FURNACES

E. V. Kochinev, Director of the School

Translated from Metallurg, No. 1,
p. 34, January, 1961

During 1958-1960 at the Krivoi Rog, "Azovstal' ", Chelyabinsk and Il'ich Plants and also at the Nizhnii Tagil Steel Combine and other places blast furnaces of 1719 m^3 volume were blown in. In September 1960 the State Scientific and Technical Committee of the USSR and the Scientific and Technical Department for Ferrous Metallurgy organized an interplant school to study the operation of the five large capacity blast furnaces.

Twenty-five specialists took part in the work of the school: representatives of ten steel plants and combines, six research and three planning institutes. Studies were made of furnaces at the "Azhovstal' ", Il'ich, Krivoi Rog, Chelyabinsk and Nizhnii Tagil Combine Steel Plants. When the school started work these furnaces had been operating for 1-2 years.

The students studied the operation of the furnaces, listened to reports of the blast furnace superintendents and laboratory superintendents, and made recommendations for improving the operation of large capacity blast furnaces and for the design of new blast furnaces of 2,000 m^3 volume and above. The work of the school attracted the technical personnel of the plants, design organizations, and research institutes in the regions of the investigated plants. The superintendents of the blast furnace departments agreed with the recommendations, which were confirmed by the managers of the plants under discussion.

The school devoted much time to problems which were discussed with great interest at the previous All-Union Conferences of Blast Furnace and Sintering Plant Workers. Among the problems discussed were whether large capacity blast furnaces could achieve better technical and economic indices than ordinary furnaces, whether the increase in volume of the blast furnaces causes insurmountable difficulties in operation, whether a large capacity furnace could be designed with a rational profile giving good distribution of the gas stream in the furnace and normal operation of the hearth. The desirability was also discussed of further increasing the volume of blast furnaces during planning and construction.

The school arrived at the following conclusions:

1. Large blast furnaces are very productive and economical. The technical and economic indices of operation in these furnaces are better than the regular furnaces. The labor productivity at large capacity furnaces is 20-25% higher and the cost of the iron is 1-5% lower than at small capacity furnaces.

An important condition for good operation of large volume furnaces is the high quality of the charge.

2. Increasing the dimensions of the furnaces has not caused any complications. Any troubles which arise can be overcome by the well-known methods. Experience in operating large capacity blast furnaces shows the desirability of further increasing their volume.

3. The profile of the 1719 m^3 furnaces is rational and gives good technical and economic indices for operation of blast furnaces on prepared materials.

4. The designs of furnaces, auxiliary devices, and their equipment mostly fulfill operating requirements and work satisfactorily. However, the designs of some units should be improved.

The school again emphasized the necessity for further improvement in the quality of the charge and the supply of well prepared raw materials and high quality fuel to large capacity blast furnaces. The special importance was also emphasized of developing measures to help the furnace workers and mechanize furnace work.

The school recommended a number of measures to improve the charge for large capacity furnaces, for blowing-in and a system for operating them, for designing furnace and equipment.

The conclusions and recommendations of the school were approved by the All-Union Conference of Blast Furnace and Sintering Plant Workers held in Magnitogorsk on October 25-29, 1960, and the decisions of the conference were included.

NEW BOOKS

B. Ya. Ryabin'kii. The Planning and Economics of Steel Plants.

Moscow, Metallurgy Press, 1960, 736 pages.

Translated from Metallurg, No. 1,
p. 34, January, 1961

This second edition of the book by B. Ya. Ryabin'kii contains a good deal more material than the first edition. After presenting the general problems in planning production at steel plants, the author proceeds to consider the organizational and technical structure of the plants, considers in detail the planning of the use and increase in capacity of the basic funds of the plants, and characterizes the production program.

Much of the book is taken up with problems of planning in the main, secondary, and auxiliary departments of steel plants. He discusses in detail principles for planning material supply, labor, wages, and production costs. At the end of the book he deals with problems of drawing up a budget and production planning.

The book by Ryabin'kii will be definitely useful for economists, engineers, technicians, and managers of ferrous metallurgy plants.

A. G.

International Relations

WITH THE LUXEMBOURG METALLURGISTS

I. S. Burdin
Translated from Metallurg, No. 1,
pp. 35-37, January, 1961

On the invitation of the Federation of Free Trade Unions of Luxembourg a delegation of Soviet metallurgists visited Luxembourg from the 8th to the 19th of October, 1960. The party included workers of the Central Committee of the Steel Industry Trade Union, I. I. Samusenko (leader of the delegation), I. S. Burdin, and also a representative of the Dnepropetrovsk Regional Committee of the Steel Industry Trade Union E. V. Stolyarskii and steel smelter of the Nizhnii Tagil Steel Combine, Deputy of the Supreme Soviet of the USSR, V. N. Luk'yanov.

In the city of Luxembourg—the capital of the country—we were warmly welcomed by the leaders of the National Federation of Free Luxembourg Trade Unions. After two hours we were in the city of Esch, the largest steel making center in the country.

Iron ore and steel comprise the main wealth of this small state (the area of Luxembourg is 2586 km^2, the population is a little more than 300 thousand).

The industrious people of Luxembourg love their country. Everywhere, on the fronts of houses, in restaurants, rooms of hotels one could see pictures and posters praising the labor of miners and steel workers. In the restaurant of the Hotel "Falstaff", in which we lived, hangs a large poster showing a worker pushing a trolley by hand. By its side there is another picture showing the same worker with a glass of beer in his hand inviting one to drink. Even the advertisements here have labor as their underlying theme.

On the front of the town hall on a steel plant background are written the words of the old national song: "We want to stay as we are."

We visited the ore mine of the "Arbed" firm on the French border. The deposits of ore at the ore mine are in a band of length 30 km and width 5 km; they are a continuation of the French deposit. The ore is at a depth of 5-50 m. The ore content in the iron is 30-35%, but there are sections where it falls to 15%. Despite the low

quality ore, the ore mine makes a profit because the open cast method is used,with low expenditure in manpower and materials. There are two types of ores: silicon and carbonate. The demand for carbonate ores is great; they are, therefore, worked more intensely.

Fig. 1. The Soviet steel delegation talks with workers of the "Rodange" Plant.

According to the chief trade union delegate who accompanied us (the President of the Factory Committee of the Union), at modern rates of working the reserves of ore at this section will last 50-60 years. The total output of the mine is 8-10 thousand tons of ore per day or 2 million tons per year.

After shallow stripping the ore seam is drilled by pneumatic machines and is blasted. The ore is mainly soft and it can be broken down with small charges. The blasting is carried out once or twice a shift. The ore is removed by electrical excavators with 2-3 m^3 buckets. The ore is taken to the crushing plant in 20-30-ton dump trucks made by the American-Belgian firm "Letourneau-Westinghouse."

Average Monthly Production of Metal in Luxembourg, thousands of tons

Type of production	Years			
	1957	1958	1959	1960 (9 months)
Iron	280	280	287	314
Steel	291	281	305	340

During its stay in Luxembourg the delegation visited five steel plants, covering practically the whole of the steel working activities of the country. In Luxembourg the plants are mainly owned by the trusts "Arbed", "Hadir", and "Miniere et Metallurgie de Rodange."

At the plants of the leading concern "Arbed" which owns 65% of all steel making capacity, there are 17 blast furnaces and 5 steel smelting departments. The large firm "Hadir" (25% of the production capacity) has 10 blast furnaces and several steel smelting departments. The company "Rodange" (10% of the capacity) has 5 blast furnaces.

All the Luxembourg Steel Plants which we visited were built at the end of the 19th and the beginning of the 20th centuries, but their equipment and units have been redesigned and modernized. New departments are also being built.

Luxembourg has no coke-chemical production, this material being imported from Belgium, West Germany, and Holland. Since the local ores contain a rather large content of phosphorus (up to 0.5%), the steel is mainly produced by the basic Bessemer process.

At the present time the market conditions are rather favorable for the Luxembourg steel industry. Orders have already been received for the delivery of metal during 1961. Most of the metal is exported to West Germany and other European countries and orders have also been received to send rolled steel to India.

Recent years have seen a certain increase in production of iron and steel (table).

There is every reason to assume that in 1960 they will smelt more than 4 million tons of steel.

As a result of the favorable market conditions at the present time there is no unemployment in Luxembourg. This is also due to the fairly high standard of living of the workers. However, going a little deeper it can be seen that the life of the ordinary worker is not so easy. It is sufficient to say that the worker must make a monthly contribution of 4% of his total pay to sickness insurance and 5% for retirement insurance. Adding to this the exceptionally high cost of accommodation, reaching 25% of wages, and certain other deductions it can be seen that almost 40% of the worker's pay is taken in the form of various contributions.

According to existing law, the length of the working day in Luxembourg factories is 8 hours (48 hr a week). At the steel and ore plants by collective agreement the working week is 44 hr. The workers are given vacations with average pay. The length of the vacation depends on the work record at a given factory. Those who have worked 3 years are given 8 days vacation, 5 years–12 days, and over 6 years they are allowed 18 days vacation.

Fig. 2. The Soviet delegation in the Factory Committee of the "Rodange" Plant Trade Union.

The worker is not given sick pay for the first three days but after this social insurance pays him up to 60% of his average wage. In the event of injury or loss of working ability which can be blamed on production the employers pay him a pension equal to the average wage.

To obtain an old-age pension, the Luxembourg worker must reach 65 and have worked for 35 years. Steel workers are given a pension on reaching the age of 60, providing they have been insured for 35 years, and mine workers if they have worked in the mine for not less than 20 years. The pension is 30-50% of the average wage.

Female labor is not used in the steel industry. Youths over 16 work the same as adults. However, they are paid less.

In one of their articles on the visit of Soviet steelworkers to Luxembourg, the Central Organ of the Federation of Free Trade Unions, "The Free Worker", correctly stated: "We have a long way to go before we reach that humane state in social insurance which exists in the Soviet Union."

During its stay the delegation got to know the trade union movement in the country. At present there are three main trade unions: The Federation of Free Trade Unions of Luxembourg, comprising 3,000 members: The Federation of Socialist Trade Unions (the Luxembourg Workers' Union)–about 18,000 members, and the Federation of Christian Trade Unions–11,000-12,000 members. The last two unions are extremely reactionary reformist organizations.

The Federation of Free Trade Unions mainly includes steelworkers (up to 80%) and miners. It also includes a very small percentage of building workers and workers from other trades.

There are also several autonomous trade unions, but they are all under the influence of the right-wing socialists or capitalists. Their principles are the solution of internal social problems and noninterference in political problems.

The reduction in numbers of members in the Federation of Free Trade Unions (after the Second World War it had up to 10,000 members) is explained by the leaders of the federation as being due to the effect of cold-war propaganda in the country, especially after the events of February 1948 in Czechoslovakia. The Catholic Church also plays a large part in anti-Communist propaganda. On entering the churches one can see posters in which the Soviet Union is shown in the form of a red dragon devouring the world. The poster carries the caption: "If you do not pray, Communism will come."

Despite its small numbers, the federation has authority among the Luxembourg workers. Some workers who belong to the reactionary trade unions secretly vote for the delegates of the free trade unions and support their principles.

In the last elections in January 1959 to the Workers Production Councils of the main steel plants the candidates of the Federation of Free Trade Unions obtained 37 places (Catholics 22 places, socialists 44 places) and at the "Rodange", "Esch" Plants and at the ore mines the representatives of the Production Councils are members of the Federation of Free Trade Unions. The leaders of the Federation are of the opinion that they now have the most progressive workers of the steel industry—the most important section of the country. The order of the day for the federation is now to attract new members into its ranks. However, workers who are intimidated by the Catholic Church propaganda and the danger of losing their jobs are afraid to enter the ranks of the Federation although inwardly sympathizing with it.

The government and administration of the works are doing everything in their power to limit the influence of the Federation of Free Trade Unions. The Federation is unable to take part in the collective agreements. At some plants the members of the Production Councils from the federation need the permission of the administration before they can visit the departments of the plant and talk with the workers.

The Federation is now putting forward the following main demands.

1. Reduction in the working week from 44 to 40 hours without loss of pay.

2. Financial assistance for workers living in private apartments.

3. Increased pay for night work up to 25% per hour.

4. Payment of vacation money before leaving for vacation.

5, An over-all increase in wages.

6. Work for peace and disarmament.

The announcements of the Federation leaders state that these demands must be worked for "by peaceful means." Active strikes cannot be used because of the high level of economic development and the high standard of living of the Luxembourg workers.

The delegation met the active trade unionists of the steel plants, the members of the Central Committee and Executive Committee of the Federation, workers and intelligentsia of Luxembourg. Before leaving for the USSR, the delegation met the Minister of Labor, Social Security, and Health of Luxembourg, Colling.

All the meetings between the delegation and workers and intelligentsia of Luxembourg took place in a warm and friendly atmosphere. The people of Luxembourg listened with great interest to the speeches of the Soviet comrades, asked many problems about trade union work, pensions, wages, the education system, vacations of workers in the Soviet Union, etc.

The trip helped to fortify the contacts existing between the workers of both countries. It was decided to organize an exchange of correspondence between several steel concerns in the Soviet Union and Luxembourg. The visit of the Soviet delegation to Luxembourg has helped to increase the authority of the Federation of Free Trade Unions.

NEWSPAPER EXTRACTS

Translated from Metallurg, No. 1, p. 37, January, 1961

The Department of Communist Labor. On the eve of the 43rd anniversary of The Great October Socialist Revolution the steel melting department of the No. 1 plant of "Dneprospetsstal'" has acquired the title of Collective of Communist Labor. This department has considerably overfulfilled its annual quota for the smelting of steel. The productivity has reached a level which was planned for 1965.

On the eve of the 43rd anniversary of The October Revolution the grand title of Collectives of Communist Labor has been given to the No. 1 open-hearth and electric melting departments of the Kuznets Steel Combine. The steel smelters of the first open-hearth department have achieved remarkable successes: they are credited with producing thousands of tons of metal in excess of the plan. A record steel yield has been achieved—10.25 ton/m^2 of hearth area. By the 7th of November the collective of the electric smelting department had fulfilled its annual quota for the melting of metal.

Target Reached. The collective of the "Élektrostal'" Plant volunteered to save 4.5 million kw-hr of electrical power in a year. The promise is being fulfilled: during the 10 months of 1960 they have saved 4.181 million kw-hr of electrical power.

More Economic Operation. At the end of 1960 the paper "Kramatorskii Metallurg" of the Kuibyshev Plant ran a course in the paper on the reduction of costs per ruble of commercial production. Workers and engineers from the plant took part in the course. The result of the course was that many faults have been discovered and ways have been found for removing them.

Further Education. In order to improve the qualifications of the engineering departments at the Kuznets Steel Combine, in collaboration with the Siberian Metallurgical Institute courses have been organized in preparation for degree examinations. The courses are being taken by 88 men, including the superintendent of hearth work of the blast furnace department, Comrade Ashpin, superintendent of the furnaces of the blast furnace department, Comrade Shatlov, Parfenov, Khadarin, roll-groove designer of the roughing mill, Comrade Mirenskii, and others.

800 Part-Time Students. In 1960 about 800 workers of the "Dneprospetsstal'" Plant studied in evening and correspondence courses without interrupting their work.

Production Increase. By the end of 1960 the increase in production at the "Dneprospetsstal'" Plant compared with 1958 was 40.5% in steel smelting and 5.7% in rolled production.

In 1961 the output of steel compared with 1958 will be increased by 51%, rolled production by 19.5%, and the labor productivity will be increased by 45%.

SOME PROBLEMS IN THE TECHNOLOGY OF THE BASIC CONVERTER PROCESS

M. I. Yampol'skii and E. V. Ivanov

Translated from Metallurg, No. 1,
pp. 38-39, January, 1961

The converter department of the Jones and Laughlin Steel Corporation Plant was started on February 11, 1957*. The converters were lined with magnesite-dolomite brick on a tar binder. The weight of a heat is 73 tons, average oxygen consumption 184 m^3/min; time of blowing 20.5 min.

Most of the metal is low-carbon killed and rimmed steel (0.15-0.30% C), used in the production of tinplate, continuous welded tubes, nails, and also construction profiles. A small amount of medium- and high-carbon steel is smelted for seamless mains and drivepipes, spring and cable wire, special strips.

Depending on the temperature of the iron and the content of silicon in it 25-35% scrap is added to the charge. The final temperature of the metal varies between 1588 and 1605°. To reduce the temperature scrap is added and to increase the temperature the metal is blown with oxygen.

To create the best conditions for finishing and reducing phosphorus and sulfur to an accepted level the slag basicity should be 2.8-3.2, which is achieved by adding lime at the start of melting in amounts calculated from the silicon content in the iron.

Basicity higher than 3.2 does not noticeably improve the dephosphorization and desulfurization, it increases the cost of the additions and reduces the metal yield. For a 73-ton heat when pouring iron with a temperature of 1343° and 1.25% Si about 4290 kg of roasted lime is added.

Furthermore, for more rapid solution of the iron 272 kg of fluorspar and 554 kg of rolling scale are added.

The most important factor in obtaining a mobile slag is the presence of iron oxide in it. However, too much Fe_2O_3 causes the slag to be thrown out during blowing; if there is not sufficient, metal is thrown out. The composition of slag in a heat containing 0.05% C is given below:

Free iron	FeO	Fe_2O_3	SiO_2	CaO	MgO	MnO	P_2O_3	Remarks
17.50	15.50	8.10	15.70	47.00	3.70	4.20	1.37	Typical slag
10.60	8.51	5.72	20.30	52.50	2.54			Metal thrown out, fusion of tuyere (final content of P_2O_5 20%)
22.00	19.60	9.72	15.20	43.30	1.60			Slag thrown out

The phosphorus content in the steel is reduced with increase in iron oxide in the slag. The average phosphorus content in the steel in the last half year was 0.012%, and sulfur 0.0198%. The table shows the relationship between the content of sulfur in the steel and iron.

* Blast Furnace and Steel Plant, 1960, No. 5.

When melting low-carbon steels the metal is blown until the carbon content is 0.05%; if necessary the temperature is adjusted and during tapping carburization is carried out in the ladle. The composition and temperature of pig iron and blown steel in the converter are given below, %:

	C	Mn	P	S	Si	Temperature, °C
Molten iron	4.50	0.45	0.110	0.025	1.25	1343
Steel at end of blowing	0.05	0.12	0.011	0.020	–	1593

In the production of low-carbon steels the coefficient of utilization of manganese is 65-75%. To the ladle is added 45.3 g of aluminum per 1 ton of rimmed and killed steel and less than 45.3 g of aluminum shot per 1 ton of steel during pouring.

Most of the sheet ingots of killed steel are poured at minute intervals between the end of pouring and the covering of the molds. If less active rimming is needed, 136 g of aluminum per 1 ton of steel is added to the ladle.

Steel with 0.15-0.25% C obtained by carburization in the ladle rims better than steel tapped with the carbon content according to analysis. However, to produce suitable rimming in the molds an intensifier must be added –453 g of iron oxide and 113 g of sodium fluoride per ton of steel.

Semikilled steels with 0.15-0.30% C are also produced by carburization in the ladle. The coefficient of utilization of carbon additions is 70-80%. During deoxidation in the ladle 816 g of 50% ferrosilicon and 272 g of aluminum are added to the ladle and 113 g of aluminum is added to the mold.

To produce steel with 0.40-0.75% C the tuyeres at the end of blowing are raised 0.3-0.6 m above the normal position and to increase the content of iron oxide in the slag by 25% the oxygen flow is reduced.

At the end of the calculated period the blowing is stopped, the temperature measured and the carbon content determined; if necessary the blowing is recommenced. When the heat is tapped into the ladle the whole amount of ferromanganese, ferrosilicon, and aluminum is added. A good stream and low height of fall for the metal tend to give more complete utilization of the manganese.

Degree of Desulfurization during Oxygen Smelting, %

Sulfur content		Degree of desulfurization
in pig iron	in finished steel	
0.020	0.016	20.0
0.035	0.021	40.0
0.050	0.028	44.0
0.070	0.036	49.0

The mean nitrogen content in all ladle samples is 0.0031%; in samples taken from the converter at the end of blowing the figure is 0.001-0.002%.

It has been found that during blowing the nitrogen content doubles. To prevent this, 90.7 kg of carbon is added to the converter and carbon monoxide is liberated during blowing.

NEW BOOKS

Translated from Metallurg, No. 1, pp.39-40, January, 1961

P. I. Polukhin, N. M. Fedosov, A. A. Korolev, and Yu. M. Matveev, Rolled Steel Production. Moscow, Metallurgy Press, 1960, 966 pages.

This is the first comprehensive textbook covering all forms of rolled production with regard to construction, calculation, and operation of equipment, technology and roll-groove design.

The first part of the book deals with general problems in rolling production; the basic principles are given for the technological process of rolling, gages and rolled steel, the purpose and classification of rolling mills, the preparation of materials for rolling. Roll-groove design is considered in detail; the basic calculations are considered for reduction systems, the pressure of metal on the rolls and power during rolling; the principles of design and various systems of passes are given.

The second part of the book deals with the production of different forms of rolled production. It considers the designs and gives characteristics of mills and auxiliary equipment; considerable space is devoted to the automation of equipment and the technical and economic indices of rolled production.

The book also gives material on the production of curved profiles from strip and also the production of bimetallic and multilayer rolled material.

The book is well illustrated with drawings, photographs, and tables. It is intended as a textbook for students at engineering schools specializing in "Metal Forming" and may be useful for engineers and technicians in the steel and engineering industries.

S. S.

N. D. Lomakin, Roughing Mills. Moscow, Metallurgy Press, 1960, 148 pages.

The book describes the equipment of roughing mills, their operation, and the technological process of rolling.

Information is given on rolling production, on the theory of rolling, principles of roll-groove design, and the development of reduction arrangements. The book describes the mechanization and automation of individual units and mechanisms in roughing mills.

The book also deals with technical and economic indices, the organization of quality control of rolled material and also possibilities for the development of roughing mills.

The book is intended as a textbook for the training of rolling mill operatives and may be useful for workers in other specialties of rolling mills.

S. S.

A Valuable Book for Soviet Economists

For workers in plants, Councils of National Economy, ministries, planning organizations, dealing with problems in the economic life of the country, the State Scientific Press "Soviet Encyclopaedia" has produced a book, "The Economic Life of the USSR. A Record of Events from 1917 to 1959." In this publication, the first to appear in the Soviet Union, there is extensive documentary material covering the history of development of all branches of the socialist economy.

In preparing the book for press, the publishers have used material obtained from industry, various ministries, committees, and departments giving copious information on the history of separate branches of the economy, on technical progress in industry (the building of factories, development of new production, new types of machines, etc.), on problems of organization and security of labor, and on wages.

The book consists of 42 chapters. Each chapter deals with a separate year in the history of development of the Soviet economy from 1917 to 1959. Each chapter has a brief introduction with the characteristics of the particular year, the internal and external politics of the country. The most important events of the economic life of the country are dealt with in chronological order. The dates are given, the name of the events, a brief description and a reference to the source to which the reader can turn for more detailed information. Each chapter ends with the economic balance sheet for the year.

The book is intended for a wide circle of readers. It will serve as a reference book for workers in industries, ministries, Councils of National Economy, planning organizations, and also for research economists.

Ya. B.

In the second quarter of 1961 Metallurgy Press will publish the following books:

V. L. Agre and Yu. Ya. Vatkin, Equipment for the Production of Steel Pipes. 11 sheets, price 70 kopecks.

The book deals with general information on modern tube mills, basic methods for producing welded and seamless tubes and also for finishing. It deals with the organization of tube mill production, the basic equipment of modern installations for tube production.

The book is intended for young workers and students in professional and technical schools.

I. I. Bornatskii, The Physical Chemistry of the Basic Open-Hearth Process. 18 sheets, price 1 ruble 5 kopecks.

The book deals briefly with the fundamental concepts and laws of physical chemistry. It considers melts of metals and slags and the physico-chemical processes occurring in the basic open-hearth furnace during the melting periods, during pouring and solidification of the ingot.

The book is intended for workers in research institutes and engineers of steel smelting departments of steel and engineering plants; it can also be useful for students of technical universities.

D. Z. Savostin, The Open-Hearth Production of Steel. 17.5 sheets, price 1 ruble 3 kopecks.

The book deals with experience in the production of steel in the modern open-hearth furnaces of the Kuznets Combine. It deals with the improvement of open-hearth furnace design, the thermal system and automation, and also problems of increasing steel production.

The book is intended for engineering and technical workers of steel smelting departments of steel and engineering plants; it may be useful to students of technical universities.

N. V. Okorokov, The Electromagnetic Mixing of Metal in Steel Melting Arc Furnaces. 10.64 sheets, price 68 kopecks.

The book discusses the results of a comparative study of mixing devices of various types and designs, gives examples of geometrical and electrical parameters of mixing devices and recommends designs for their practical use.

The book will be useful for engineers and technical workers of steel plants and also students at technical universities.

The Conversion of Phosphorus Irons in Open-Hearth Furnaces. By a group of authors, edited by Ya. A. Shneerova 15 sheets, price 90 kopecks.

The book presents material on methods for converting phosphorus irons without using oxygen and with its combined use. It deals with factors helping to reduce the time of heats, to produce high quality steel and phosphate slags for fertilizers.

The book is intended for engineers and technicians of steel and engineering plants and also for workers in research organizations.

The prices and sizes of the books are approximate. Order the books which you need now from your local branch of Knigotorg.

SIGNIFICANCE OF ABBREVIATIONS MOST FREQUENTLY ENCOUNTERED IN SOVIET PERIODICALS

FIAN	Phys. Inst. Acad. Sci. USSR.
GDI	Water Power Inst.
GITI	State Sci.-Tech. Press
GITTL	State Tech. and Theor. Lit. Press
GONTI	State United Sci.-Tech. Press
Gosenergoizdat	State Power Press
Goskhimizdat	State Chem. Press
GOST	All-Union State Standard
GTTI	State Tech. and Theor. Lit. Press
IL	Foreign Lit. Press
ISN (Izd. Sov. Nauk)	Soviet Science Press
Izd. AN SSSR	Acad. Sci. USSR Press
Izd. MGU	Moscow State Univ. Press
LEIIZhT	Leningrad Power Inst. of Railroad Engineering
LET	Leningrad Elec. Engr. School
LETI	Leningrad Electrotechnical Inst.
LETIIZhT	Leningrad Electrical Engineering Research Inst. of Railroad Engr.
Mashgiz	State Sci.-Tech. Press for Machine Construction Lit.
MEP	Ministry of Electrical Industry
MES	Ministry of Electrical Power Plants
MESEP	Ministry of Electrical Power Plants and the Electrical Industry
MGU	Moscow State Univ.
MKhTI	Moscow Inst. Chem. Tech.
MOPI	Moscow Regional Pedagogical Inst.
MSP	Ministry of Industrial Construction
NII ZVUKSZAPIOI	Scientific Research Inst. of Sound Recording
NIKFI	Sci. Inst. of Modern Motion Picture Photography
ONTI	United Sci.-Tech. Press
OTI	Division of Technical Information
OTN	Div. Tech. Sci.
Stroiizdat	Construction Press
TOE	Association of Power Engineers
TsKTI	Central Research Inst. for Boilers and Turbines
TsNIEL	Central Scientific Research Elec. Engr. Lab.
TsNIEL-MES	Central Scientific Research Elec. Engr. Lab.—Ministry of Electric Power Plants
TsVTI	Central Office of Economic Information
UF	Ural Branch
VIESKh	All-Union Inst. of Rural Elec. Power Stations
VNIIM	All-Union Scientific Research Inst. of Metrology
VNIIZhDT	All-Union Scientific Research Inst. of Railroad Engineering
VTI	All-Union Thermotech. Inst.
VZEI	All-Union Power Correspondence Inst.

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LÉT	Leningrad Elec. Engr. School
LÉTI	Leningrad Electrotechnical Inst.
LÉTIIZhT	Leningrad Electrical Engineering Research Inst. of Railroad Engr.
Mashgiz	State Sci.-Tech. Press for Machine Construction Lit.
MÉP	Ministry of Electrotechnical Industry
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UF	Ural Branch
VIÉSKh	All-Union Inst. of Rural Elec. Power Stations
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